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Reproduction in Plethodont Salamanders of the Genus *Hydromantes*[1]

By Joe Gorman

Largely on the basis of circumstantial evidence based on observations of *Hydromantes italicus* Dunn (1923) the salamanders of the genus *Hydromantes* are thought to bear live young. In addition to *H. italicus*, other species of the genus are *H. genei* Schlegel (1838) of Sardinia and *H. platycephalus* Camp (1916) of the Sierra Nevada of California. Recently two more species have been described, *H. shastae*, in northern California (Gorman and Camp, 1953) and *H. brunus*, in the Sierran foothills of central California (Gorman, 1954). *Hydromantes shastae* is much like *H. italicus* in form and habits. Ecologic and systematic papers are in preparation.

Chronological Review of the Literature

Sometime after Schreiber (1875) suggested that the viviparity of the European land salamander, *Salamandra atra*, was unique in the class Amphibia, it was thought that *Hydromantes italicus*, then known as *Geotriton* or *Spelerpes fuscus*, might be live-bearing. Evidently the first explicit statement of this was that of Camerano (1884) who, after reviewing its natural history and comparing it with that of *Salamandra atra*, suggested a "sort of viviparity" (perhaps meaning ovoviviparity). Rossi (1894) cites Camerano, but points out finding eggs without a trace of embryonation in the terminal portion of the oviducts. Berg (1896) reports finding his first "newborn" *Spelerpes*, 36 mm. in (?total) length, in his terrarium ("Spelerpes-Haus"). This one was followed in 18 days by three more. He reported a fifth young, of 38 mm., but all died in a few weeks. He reviewed the evidence on reproduction and likened that of *Spelerpes* to *Salamandra atra*. Bedriaga (1897) also reported "newborn" young, 24 mm. in length, as well as the deposition of a spermatophore

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in October, in captivity, and the subsequent development of eggs the next year in the female he thought to be the mother of the first young.

Terni (1911) made careful studies of spermiogenesis in *Hydromantes italicus,* mainly on captive animals, and tried to correlate his findings with those based on specimens recently taken in the field. He concluded that *H. italicus* males had sperm in the ducts, but not tubules, in nearly all, or perhaps all, months of the year. Two male *H. platycephalus* taken May 29, 1955, from Half Dome, Yosemite National Park, California, were examined by Dr. James Kezer of the University of Oregon a month after their capture. He states: "In both animals the ducts contained many living sperms . . . Apparently these sperms have been in the ducts for months. The present condition of the testes indicates that there has been no recent opportunity for sperm production."

Schreiber (1912), mainly following Berg (1896), considered both land salamanders, *Salamandra atra* and *Spelerpes fuscus* (=*Hydromantes italicus*) as viviparous and Procter (1920) exhibited and remarked on a "newborn" *Spelerpes fuscus,* Mertens (1923) writes of a "Liebspiel" of

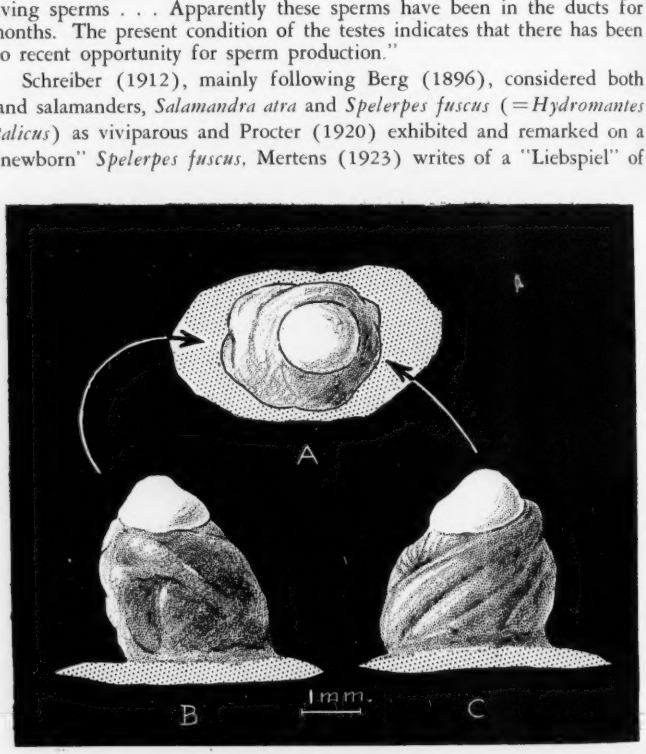

Fig. 1. Spermatophore of *Hydromantes brunus* deposited in captivity between May 25 and 29, 1955. The male and an accompanying female had been in a gallon jar in a refrigerator about 2 months, at a temperature of 3 to 4°C. The spermatophore is shown from above, A, and in lateral aspect, B and C, as viewed from the position of the arrows. The sperm capsule had become separated from the jelly base but has been drawn in its presumed former position.

his captive *Spelerpes fuscus*, here treated as *Hydromantes genei*, which occurred on April 10, 1923, and lasted 15 minutes. He describes the brightly colored male making advances at the female, which was under moss and responding with "peculiar" writhing tail movements. The male rubbed first the tail and then the head of the female, who then crept out of the moss. The male mounted her, his head over hers, his forelegs clasping her body just behind her axillae, and his body and tail closely pressed to hers. Then both began waving their tails "wildly". The female crawled forward, carrying the male for a short distance, but in 3 to 4 minutes the male let the female go, but returned shortly thereafter. He again climbed on her back, clasping her in front of the forelegs, and again the tail writhing occurred. The tail action of the female was especially evident. He left her again shortly, but followed her onto the glass terrarium wall, again climbing on her back; both fell to the floor of the terrarium. The female then went quickly back to her place under a stone, and the male climbed back on the wall, staying there quietly.

Noble and Brady (1930) gave a brief account of courtship in *Hydromantes genei*, noting the deposition of a spermatophore on the top of a damp flower pot. They mentioned its similarity to that of *Eurycea*, but pointed out that it was larger and had less gelatinous material forming the base. Unlike other plethodonts (see especially Stebbins, 1949, on *Ensatina*) males were found astride females (cf. also Mertens, 1923), and there was no following of males by females. Stebbins (MVZ field notes, May 29, 1955) records finding a spermatophore of *Hydromantes brunus* (Fig. 1).

Camp (1916) noted and figured the enlarged maxillary and premaxillary teeth in the males of *Hydromantes platycephalus*, which Noble (1931: 125, Fig. 47) also shows, giving contradictory statements in text and figure legend as to their possible significance in courtship. From my systematic studies, I think the enlarged teeth and the wide head of the male of this species may be a seasonal sex character. Noble also shows a courtship pose for *H. genei* (1931: 385, Fig. 133A) and states (p. 59) that ". . . [*H. genei*] retains the eggs in the oviduct and gives birth to fully transformed young."

Cei (1942a) gave a detailed description of his "newborn" of 30 mm. total length, in which he was somewhat surprised at the adult-like development of the body in contrast to the "arrested" development of the gonads, and supposed that the maternal uterine wall aided in respiration. He found (1942b) that hothouse conditions stimulated a gonadal cycle in male *Hydromantes italicus* which was some months ahead of that of animals taken in the field at the same time of year, November to March, but noted some peculiarities in the testes in the hothouse animals. He agreed with Terni (1910) and with the findings of others on plethodonts, stating that spermiogenesis (1942b: 322) occurred only from June to [? through] September and was followed by "a complete arrest during fall in the pachytene stage, as in reptiles." (1942b: 322.) Galgano (1943) in a general view of sex cycle factors, infers a lower optimum temperature for spermiogenesis for *Hydromantes genei* (=*H. italicus*) than for other Amphibia considered.

MATERIAL AND METHOD

The major part of my ecological work with *Hydromantes shastae* was done in a small cave on Brock Mountain, Shasta County, California. On September 21 to 23, 1951, I found that all animals on the cave walls were males in apparently full breeding condition, with swollen vents and conspicuous chin glands. In the search for females, during which the mud deposits on the upper chamber walls were disturbed, two females poked their heads out of small tunnels in the mud, their sex being recognized because of the lack of chin glands. After catching and marking the first female, I went to the opening into which the second one had gone, and began carefully to remove the mud in which there was a tunnel about 1.2 to 1.3 cm. in diameter.

After following the tunnel some 15 cm. I exposed three eggs of a clutch of nine, at about 3 to 4 cm. below the surface of the mud. The female was curled about the eggs and despite much flashbulb photography, although seeming much disturbed, she did not leave them. She appeared emaciated, and after I marked her by toe-clipping, she moved away stiffly.

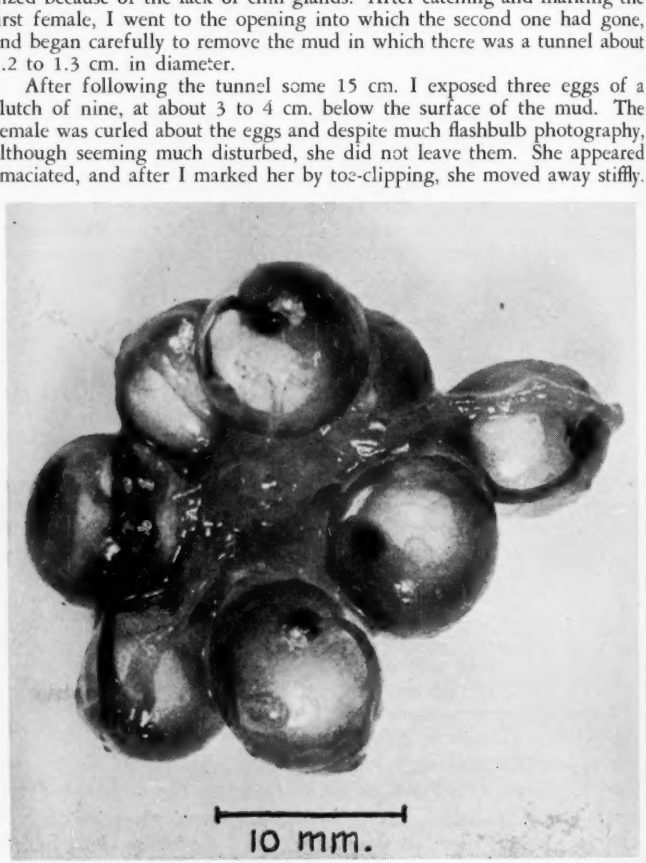

Fig. 2. Clutch of 9 eggs (one is concealed) of *Hydromantes shastae* obtained on September 23, 1951 in a cave on Brock Mountain, Shasta County, California. A female salamander was with the eggs at the time of their discovery. Photograph taken by O. P. Pearson.

The larvae were clearly those of *Hydromantes* even to the interdigital membranes on the hind foot. They had gills and large yolk sacs. The eggs were carefully removed and placed in a carton. During their transport to the laboratory, the carton leaked and the eggs were submerged in water for 12 to 24 hours at about 10-12°C. When first examined, the larvae were inactive and blood in the gills was not circulating, but all later revived. One larva with a growth on its neck was preserved at this time. The outer egg capsule of another egg was removed to allow closer examination and a moving picture study of the intra-oval larva; the egg was then preserved.

On November 1, 1951, I made another trip to the cave, and found another clutch of eggs. It was at the enlarged end of a small tunnel about 1.3 to 1.6 cm. in diameter and 14 to 16 cm. long; the eggs were about 5 to 6 cm. below the surface of the mud. A female was curled around them; when exposed she left the eggs readily, but moved stiffly. There were nine eggs in this clutch also, and the larval gills and yolk sacs were much smaller. One egg hatched before reaching the laboratory.

The eggs (Fig. 2) are much like those described for other plethodonts, perhaps most nearly like those of *Aneides lugubris* (Hallowell, 1849) among western North American plethodonts. They are attached by one or two outer capsular strands to a central mass of intertwined strands.

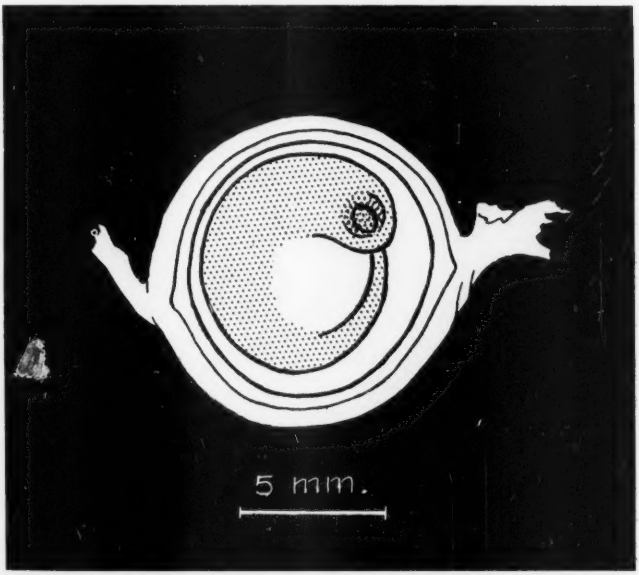

Fig. 3. Diagrammatic representation of one of the eggs shown in Fig. 2. Note the two-layered jelly capsule and remnants of the jelly strands that connected the egg with others in the cluster.

When two strands are present they originate at opposite poles of the egg. Two of the strands were 11.1 and 7.7 mm. in length from the point of attachment to the egg. In the first clutch most eggs had two strands; in the second, most had one.

Each egg is subspherical to ovoid in shape (Fig. 3), about 8 to 9 x 7 to 8 mm. The dimensions of a "typical" egg with its larva, after 3 to 4 days in 65 per cent ethanol followed by immersion in tap water for half an hour were: along the long axis of the larva to the outer capsule, 10.75 mm.; larva, curled and overlapping about 3 to 4 mm., 9.1 mm.; jelly coat, 0.82 mm. thick, inner part 0.21 mm. thick. No measuring of the live eggs was done at this stage for fear of endangering the prospect of observing hatching.

The bodies of the larvae were dark gray, with discrete melanophoric punctations (Fig. 4). This color contrasted strongly with the pale cream of the yolk mass. The gills and heart region were pink. In the embryos of the second clutch, within a week of hatching, deep yellow to gold spots appeared dorsally. The gills were small and weakly bilobed, as compared with those of *Ensatina* at a comparable stage (Figs. 4 and 5).

On October 23 the batch of eggs taken on September 23, 1951, looked like they might be ready to hatch. They were taken from the constant-temperature room (at 12 to 13°C.) to the laboratory at ordinary room temperature, about 22°C. The gills were about one-quarter or one-third their size of a month before, then about 1.8 mm. long and 1.0 mm. wide.

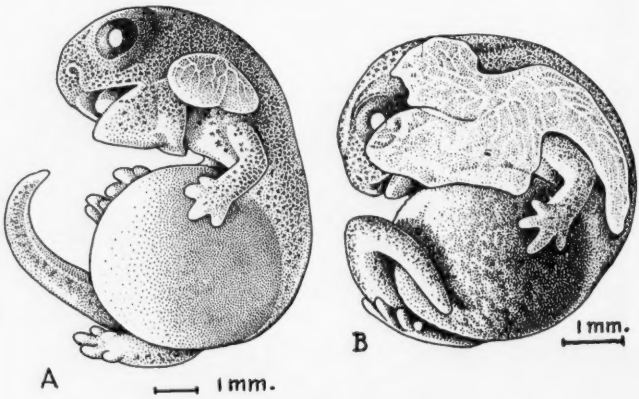

Fig. 4. A. An advanced embryo of *Hydromantes shastae,* removed from one of the eggs of a cluster found September 23, 1951, in a cave on Brock Mountain, Shasta County, California. B. An embryo of *Ensatina eschscholtzi picta* Wood (1940) at a comparable stage of development, is shown for comparison. The *Ensatina* embryo was removed from an egg cluster obtained August 9, 1949, at Big Lagoon, Humboldt County, California. Note differences in structure of gills and toes. Drawings based on preserved specimens.

Heart rate at 22°C. ambient temperature was 76 to 78 pulsations per minute, at 26°C., 95-98 per minute. The yolk sacs were smaller and almost spherical in ventral view, 4.1 mm. long by 3.7 mm. wide; the costal folds seemed to be growing down over them. Chromophores (non-melanic chromatophores, Gorman and Camp, 1953: 40) now were clearly seen as gold flecks. Response to light was strong, to sunlight much stronger, and consisted of a series of jerks of the body and thrusts of the limbs. There seemed to be a definite righting reflex; when the egg was turned so that the larva was belly-up there was a delay of 2 to 3 seconds, then a wriggling movement of 3 to 4 seconds during which the animal turned dorsal side up and the movements ceased. An effort to stimulate hatching by use of light and heat was not successful. After about two hours of observation, during which there seemed to be no efforts "directed" toward hatching, I judged the larvae were not yet ready and returned them to the 12-13°C. room.

On October 30, a week later, the larvae seemed much more reactive. They were again placed under bright lights and action began immediately. The first indication of hatching was a tail breaking through at 8:09 A.M. (air temperature next to the egg, 24.9°C.). The salamander lay quietly for two minutes, then started to move, sometimes violently, until finally it was free of the egg mass at 8:20 A.M. (24.6°C.). At 8:24 A.M. (26.4°C.) another larva writhed violently and burst out of the egg at 8:25 A.M. (28.8°C.). At 8:29 A.M. two larvae were active, but then became quiet. The larvae seemed to become specially active at a temperature of 29+°C. Often some were so still as to seem dead. Some eggs containing larvae were deflated, as if a rupture had occurred that allowed the fluid to leak out. One of three (turgid) eggs had a bubble like that in a spirit level. At 10:42 A.M. (25.1°C.) one larva, after preliminary

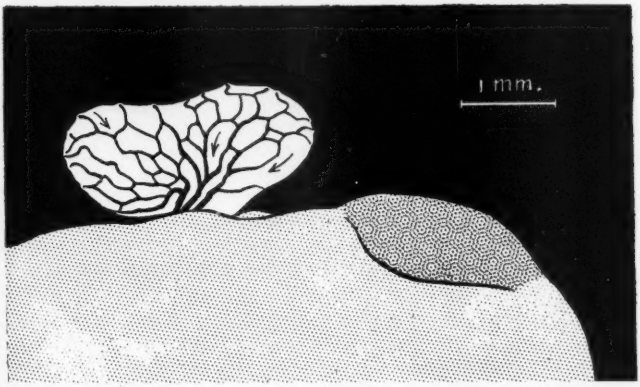

Fig. 5. Details of shape and vascular network of the gill of the *Hydromantes shastae* embryo shown in Fig. 4. All blood vessels on upper side of gills are shown. A similar network is present on lower side. Arrows indicate direction of flow of blood. Note that gill epithelium is slightly elevated over the blood vessels.

movements, suddenly emerged partly from the capsule and lay still. It stirred, however, when touched with forceps.

The eggs found on November 1, 1951, were brought to the Museum on November 4. One of the eggs had hatched on November 2. On November 8 at 10:00 A.M. the larvae were active immediately on removal from the darkness of the 12-13°C. room to the lighted laboratory. The first egg capsule burst at 10:20 A.M. (14.6°C.). The hatchling lay still for about four minutes, then began intermittent movements until it broke away from the jelly and capsule. Meanwhile the other larvae were quiet despite an ambient temperature that reached 25.5°C. The temperature was lowered and kept constant at 20.5 to 21.5°C. The second egg hatched at about 10:45 A.M. The salamander lay still for 8 minutes, then took about 26 minutes to free itself. Meanwhile, at 10:56 A.M. another hatched, lay quietly 2 minutes, then pulled itself free in about 6 minutes. The fourth individual hatched at 11:08 A.M. and was quiet 10 minutes. A fifth broke out, head and foreleg foremost, at 11:24 A.M. and was quiet 9 minutes, then took 10 minutes more to free itself. The sixth hatched tail first at 11:31 A.M., was quiet 5 to 6 minutes, then took 5 to 6 minutes to wriggle free. The seventh, at 11:44 A.M., came out head first, was quiet 6 to 7 minutes, then crawled away 4 to 5 minutes later. The eighth and last broke out tail first at 11:52 A.M. The total time required for hatching was an hour and 32 minutes.

All hatchlings were active following the quiet period just after emerging. In 5 instances emergence was head first, at least three bursting out, but in one, probably two, the head slowly emerged. The tail-first emergences were quick. Most of the eggs seemed to lose their turgor and roundness some minutes before the salamanders emerged. Three eggs required from a half-hour to an hour.

There seemed to be no tendency for the hatchling salamanders to stay near the eggs; rather, the tendency seemed to be to wander off, but confined in the 50 mm. dish, several crawled back over the egg mass. In several instances the crawling seemed to stimulate unhatched young but not to aid emergence (with one possible exception).

I think the stages of development of both clutches were within a week of each other. The eggs of the first clutch, despite the stimulation of laboratory lights and heat, did not hatch the first time they were exposed. They did hatch the next week, but five of the seven died within a week to ten days. The eggs of the second clutch hatched readily, without the violent writhings described for the larvae of the first clutch. I think the unnatural conditions forced both hatchings, the second much less so than the first, and in a much shorter period. I do not think that more than a few days would have passed between the hatching of the first and last eggs in a clutch.

An interesting question is the role of the female after laying the eggs. When the first eggs were taken, the mother did not leave the clutch despite much disturbance. The second female left her eggs, and when replaced in the jar with them, seemed to show no further interest, even after being left several days with them under favorable temperature conditions. In the weeks following hatching, when the hatchlings were replaced in the same jar with the mother, I was unable to detect any behavior of hatch-

lings or mother different from that of any salamanders confined together. The question of the extent of maternal care is unanswered.

Table 1 gives measurements of 11 newly hatched *Hydromantes shastae*. The mean total length is 23.7 mm. From measurements of other young, as well as of young *H. brunus* and *H. platycephalus*, I judge that the mean total length of the next age-year class is about 46 mm. This is in line with the growth curve made from data from marked individuals of the same cave population. An ecologic paper is in preparation.

Table 1

Snout to vent measurements (in mm.) of newly hatched *Hydromantes shastae*.

(Individuals are from the egg clusters described in text.)

	1	2	3	4	5	6	7	n	mean
total length	23.9	24.1	23.1	24.5	23.5	23.2	22.1	7	23.7
snout-vent	15.3	15.3	15.4	17.2	16.3	16.6	15.0	7	16.0
tail length	8.5		7.3	7.3	7.6	7.1	7.1	6	7.6
foreleg length	4.5	4.8	4.4				4.7	4	4.6
hindleg length	4.8	5.0	4.8				5.1	4	4.9
eye length	2.0	1.7	2.2				1.4	4	1.8
nostril-orbit	1.1	0.9	0.8				0.7	4	0.9
head width	4.0	4.0	3.9				3.3	4	3.8
interorbital width	2.1	2.1	2.2					3	2.1
yolk sac length	4.8	5.1	5.2		5.5	5.1		5	5.1
yolk sac width	2.5	2.3	2.5		1.6	1.3		5	2.0
belly width	3.9	4.1	4.1				2.0?	3	4.0
snout-vent of four additional individuals									
	16.2,	15.5,	16.3,	15.0				11	16.0

The hatchlings had all the reflexes seen in older *Hydromantes*, but seemingly slightly less perfected: tail action (Stebbins, 1947), righting response, reaction to handling such as avoidance and writhing, limb movements (but made with some difficulty because of the yolk sac "paunch"), and, some few days to a week later, the boletoid tongue action in feeding (described first by Fischer, 1887). Two young from the second clutch were preserved at the time of hatching, one died two weeks later, one died and decomposed some days before March 15, 1952, two died on that day, and the three left were then killed and preserved the next day, all as MVZ 57044-46. The yolk sacs had disappeared in some young two weeks after hatching and in the rest before the fourth week. The salamanders were kept at 12-13°C.

In form also, and as in most other plethodonts, the young were much like the adults. Teeth were present but small, the neck seemed longer relative to the head, and the nostrils were a great deal larger, relatively (cf. Mertens, 1923), the lip pendants much more pronounced, and the nasolabial groove more prominent than in adults. Except for *Hydromantes brunus* young, chromophore color is less developed in young *Hydromantes* than in adults. The young of all the California species have a much greater over-all concentration of melanic pigment. I have seen only preserved young of *H. italicus* and *H. genei*. *H. brunus* young are notably less melanic than young of other species but resemble *H. platycephalus*

young in color (Gorman, 1954: 156).[2] Cei (1942a) describes the internal, especially the endocrinal, development in young *Hydromantes italicus.*

[2] Were I to place *H. brunus* as a subspecies of *H. platycephalus,* I must so place *H. shastae* (Gorman and Camp, 1953). I think of *H. shastae* as closer to *H. italicus* than to *H. platycephalus.*

SUMMARY

The question of the mode of reproduction is answered for *Hydromantes shastae,* but not for any of the other species. The following suppositions seem warranted.

Contrary to Mertens (1951: 115) I think all the salamanders of the genus *Hydromantes* are closely related. Probably the two most different geographically adjacent species are *H. platycephalus* and *H. shastae.* Physiologic work on three California species show significant differences, but less than in form. A paper on physiology is in preparation. There is no comparable work on the European species (Cherchi, 1948, worked on thermoregulation, an aspect different from those I studied). It might be expected that species of the same genus would reproduce much alike, but there are examples of different modes of reproduction even in closely related species: e.g. *Salamandra maculosa* and *S. atra* Laurenti (1768) and the alligator lizards, *Gerrhonotus multicarinatus* Blainville (1835) and *G. coerulus* Wiegmann (1828).

Rossi (1894) found no sign of embryonation in any of the eggs, even in the terminal part of the oviduct, in *Hydromantes italicus.* Stebbens (1951) examinated all eggbearing *H. platycephalus* available at that time in the collection of the M.V.Z. with special attention to possible development of embryos within the maternal genital tract. He found only ovarian eggs, none embryonated. In subsequently collected ova-bearing *H. platycephalus* (11 specimens) and *H. brunus* (9 specimens), I got the same results. I think that female *Hydromantes* lay fertiilzed but undeveloped eggs, which hatch in the way of all known plethodonts. The statement of Dunn (1926:395, after Posada, 1909), ". . . that *Oedipus* [now *Magnadigita*] *adspersus* Peters (1863) produces live young," needs proof.

I owe much in this paper to Dr. Robert C. Stebbins for his guidance, encouragement, and use of his field notes and fine drawings. I am grateful to Dr. Charles L. Camp for much encouragement.

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MUSEUM OF VERTEBRATE ZOOLOGY, UNIVERSITY OF CALIFORNIA, BERKELEY 4, CALIFORNIA

EXTENSION OF THE RANGE OF WRIGHT'S SALAMANDER. —Three new localities for *Batrachoseps wrighti* (Bishop) have been found in western Oregon. One specimen was obtained by D. L. Jameson five miles S.E. of Clackamas, Clackamas County, Oregon, at 200 feet elevation (T2S, R3E, Sec. 15) on February 27, 1953, from under the moss of a decayed Douglas fir log in a mixed second growth Douglas fir — hemlock stand on a rocky hillside near the Clackamas River. This locality is about seventeen miles west of the type locality (Bishop, Herpetologica 1:93-5). The specimen is 90 mm. in total length and has a snout-vent length of 33 mm.

One specimen of *Batrachoseps wrighti* was obtained by R. M. Storm and James Kezer on July 2, 1955, twelve miles south of Rainbow, Lane County, Oregon (T17S, R5E, Sec. 36), at 2300 feet elevation from under the bark of a decomposed Douglas fir log. The forest is second growth Douglas fir with a big leaf maple understory. This locality, near the south fork of the McKenzie River, is eight miles south of the previously known southern limit of the species (Storm, Copeia, 1953 (1): 65-6). The specimen has a total length of 56 mm. and a snout-vent length of 30 mm.

Four wright's salamanders were obtained by D. L. Jameson 15 miles northwest of Westfir, Lane County, Oregon, on October 22, 1955, near the North Fork of the Willamette River at 2800 feet elevation (T19S, R4E, Sec. 21). Logging has removed the Douglas fir from the area leaving good stands of western red cedar. Cedar and Engleman's spruce saplings and Oregon grapes are abundant. The salamanders were taken from under the moss on and bark of the rotting stumps and logs of Douglas fir. Temperatures in the moss and logs searched ranged from 8.0 to 21.4°C as indicated by the American Museum Special Schultheis Animal Thermometer. In one log a small *Batrachoseps* was captured along with an *Ensatina eschscholtzi Gray*. The stomach temperature of the *Ensatina* was 12.6°C; that of the log at the capture site was 9.5°C. This *Batrachoseps* and one other were too small to obtain stomach temperatures. The temperature of other capture sites and salamanders found at this locality are as follows: log 9.0°C, *Batrachoseps* 10.0°C; log 14.0°C, *Batrachoseps* escaped; log 10.0°C, *Batrachoseps* 9.2°C; log 10.2°C, *Batrachoseps* too small; log 9.8°C, *Batrachoseps* too small; log 12.0°C, *Aneides ferreus* Cope 16.8°C; log 12.5°C, *Aneides* 10.0°C, *Aneides* 19.0°C; log 11.9°C, *Aneides* 11.9°C. Measurements of the *Batrachoseps* collected are as follows; total length 84 mm., snout-vent 37mm.; t.l. 83 mm., s.v. 38 mm.; t.l. 63 mm., s.v. 30 mm.; t.l. 41 mm. (tail broken), s.v. 30 mm.

This locality is 26 miles south southwest of the previously known southern limit of the species.—*David L. Jameson and Robert M. Storm, Department of Biology, University of Oregon, Eugene, Oregon, and Department of Zoology, Oregon State College, Corvallis, Oregon.*

A Snake Den in Cedar Mountains and Notes on Snakes and Parasitic Mites[1]

Angus M. Woodbury and Dale D. Parker

INTRODUCTION

On the evening of October 25, 1952, in the hills West of the new settlement of Dugway, Tooele County, Utah, Keith Conners encountered three rattlesnakes which he attempted to kill; one escaped into a hole. On October 28, he reported the incident to one of the authors (Woodbury) who suspected that he had found a snake den. Late that evening Connors guided a group to the place. The site, visited again the next day, was located at the mouth of an opening in an extinct volcanic truncated cone, an outlier of a larger volcanic mass about two miles in diameter. This mass lies at the extreme southerly and easterly tip of Cedar Mountains. The ground is a very rocky volcanic ash with a small amount of fine soil accumulated in depressions and around the bases of the scrubby desert bushes.

Vegetation on the cone consists mainly of typical scrubby desert bushes, including spiny horsebrush. *Tetradymia spinosa:* hop sage, *Grayia spinosa;* and jointfir, *Ephedra nevadensis.* The flat lands surrounding the volcanic mass are typical shadscale deserts covered with scrubby bushes, *Atriplex confertifolia,* and associated vegetation. Pigmy forests of juniper occur in higher altitudes of Cedar Mountains and in sandy soils of lower altitudes.

The hole into which the rattlesnakes escaped is probably an old vent through which the last remaining gases escaped from the dying volcano of relatively recent geological age. It may extend to great depths and may still be an escape for slowly rising gases, for in a shallow depression at the mouth of the main opening, it was observed that winter snow melted rapidly and that green grass and moss grew during cold weather when all other vegetation was dormant. The main hole itself, bevond the bottom of the depression was about three inches in diameter. There were two other similar openings nearby which were interpreted to be branching outlets to the surface, into which snakes were later observed to enter. If our interpretation is correct, snakes could descend underground as far as necessary to find a relatively stable temperature.

When first visited in the daylight, October 29, a striped racer was found sunning itself near the opening. It quickly entered the hole and was probably one of the last of the season to enter. In the bushes around the opening, eleven molted skins of striped racers were found. On the basis of former experience at the Grantsville den (see Review of Literature), it was estimated that the eleven molted skins might indicate a wintering population of 50 to 100 snakes. The den was on the brow of a hill overlooking a small valley that led down to the new settlement of Dugway, about a mile distant.

After consultation with a military representative of the Army at Dug-

[1] This work was supported by U. S. Army Chemical Corps contract, No. DA-18-064-CML-2639, with the University of Utah.

way, Lt. Col. Arden L. Bennett, it was decided that the den was too close to the settlement for the comfort and safety of the inhabitants and that the snakes should be removed. This was particularly pertinent since Woodbury had found the remains of a small rattlesnake flattened out on a street of the town where it had been run over by automobiles. Several small rattlesnakes were later found by residents around the new homes. It was, therefore, planned to trap the snakes as they emerged the following spring and use them for study.

Wide experience gained by Woodbury in hunting and studying reptile dens in this intermountain region since 1935, indicated that snakes do not make their own hibernating burrows like tortoises, but depend upon finding suitable shelters where they can avoid the lethal extremes of winter. He has found snake concentrations in dry spring channels, loose cobblestone rocks, gravel banks, rockslides, landslides, deep rock crevices and in many artificial openings in buildings, walls, garbage dumps and the like. Such dens can best be recognized by finding snakes entering or emerging from them, although in some cases molted skins of the striped racers give a useful clue.

The dens described and analyzed in the literature indicate that there is considerable difference in the component species, population numbers, size ranges and various other interrelationships. This article adds another variation in the types and composition of dens. We are especially indebted to John Smith and other members of the staff for assistance and for field information.

REVIEW OF LITERATURE

The first comprehensive account of a large snake den was given by E. Raymond Hall in 1929, when he described his encounter and investigation of a den in eastern Nevada about 100 miles from Dugway. Martin (1930) reported a snake hunt that netted a large catch at a snake concentration before they scattered for the summer. Other dens have been described by Gloyd (1941), Anderson (1947), Woodbury and Hansen (1950), and Woodbury, et al (1951). The latter is a reference to a ten year study at a den near Grantsville, Utah, not over 25 miles airline from the one treated herein.

These dens deal with undergrand shelters where snakes avoid cold extremes of winter. A den of snakes in a tree trunk, where snakes escaped heat extremes of the tropics, was described by R. C. Pendleton (1947). A winter concentration of frogs in the mud of non-freezing springs was reported by Hope (1941). Winter concentrations of tortoises in long horizontal tunnels in wash banks were described by Woodbury and Hardy (1948). A review of snake concentrations was given by Pope (1937).

METHODS AND PROCEDURES

The snake den was fenced on Feb. 23, 1953, with 30 inch screen wire standing on edge and held in place by metal posts of reinforcement steel of two sizes, $\frac{5}{8}$ and $\frac{3}{4}$ inch diameter, set in the ground and braced with rocks if the soil was too shallow. The bottom of the screen wire was set in a shallow trench one or two inches in depth, then re-filled with dirt. This effectively prevented snakes from escaping underneath. It was fastened to the posts by means of small loops of fine malleable wire, twisted to hold it tight.

The enclosure was about 20 feet in diameter. A trap was set near the entrance hole in an opening in the fence. The trap was specially constructed of screenwire on an oblong wooden frame with a funnel in one end, leading to the interior, and a door in the other end. It was designed to allow the snakes to pass through the fence via the funnel into the trap, from which they could be removed via the door. In the fall, the trap was reversed so that the funnel faced outward. This trapped returning snakes before they could enter the den.

Systematic visits were made to the den from early March to mid June and again in the fall from early September to late October. When snakes were found in the trap, they were counted and transferred to a cage in which they were taken to the laboratory for processing, holding and studying. The fence and trap were molested several times and doubtless some snakes escaped before repairs could be made. Some of the longer racers may also have escaped by climbing over the fence.

To further protect the settlers, searches were made for other dens in the vicinity and for wandering snakes around the fringes of the settlement. When searching, a long line of men (about 40 to 45 in number) spaced close enough together so that the terrain and bushes between them could be carefully scrutinized, covered a given strip of ground, then moved over and covered an adjacent parallel strip. If snakes were found or den sites suspected, the line was stopped for investigation or for catching the snakes. The hunt was started when the morning temperature reached about 60°F. This was considered to be approximately the threshold of emergence (Woodbury, et al, *op. cit.*:15-19). It was expected that the snakes would be lingering around the exit of the den to sun and get warm before departing for the summer range.

When snakes were captured, they were placed in cloth bags, securely tied and sent to the accompanying truck. When planning a hunt for snake dens during the usual period of emergence, a warm day was selected following a cool or cold night on the theory that the cold had held them back and that the warm day would entice them out to obtain warmth from the sun.

THE DEN POPULATION

The wintering population of snakes trapped on emergence from the den consisted of 49 western striped racers, *Coluber taeniatus taeniatus*, 4 Great Basin rattlesnakes, *Crotalus viridis lutosus*, and one Great Basin gopher snake, *Pituophis catenifer deserticola*. These were removed from the den between March 25 and May 18. This does not account for the snakes that may have escaped either because of molestation of the trap or by climbing the fence. It is assumed, however, on the basis of twelve years of experience with the Grantsville den that those returning to the den in the fall may have been mainly the spring escapees. The fall trapping from Sept. 21 to Oct. 26, 1953, yielded 36 striped racers and one gopher snake.

Numbers removed from trap on given dates are as follows:

During spring emergence:

Rattlesnakes: April 22, 1; May 18, 3.

Gopher snakes: April 23, 1.

Racers: March 25, 2; 31, 3; April 16, 1; 17, 4; 20, 11; 21, 8; 22, 3; 23, 2; 24, 2; May 4, 7; 5, 3; 8, 2; and 18, 1. Total, 49.

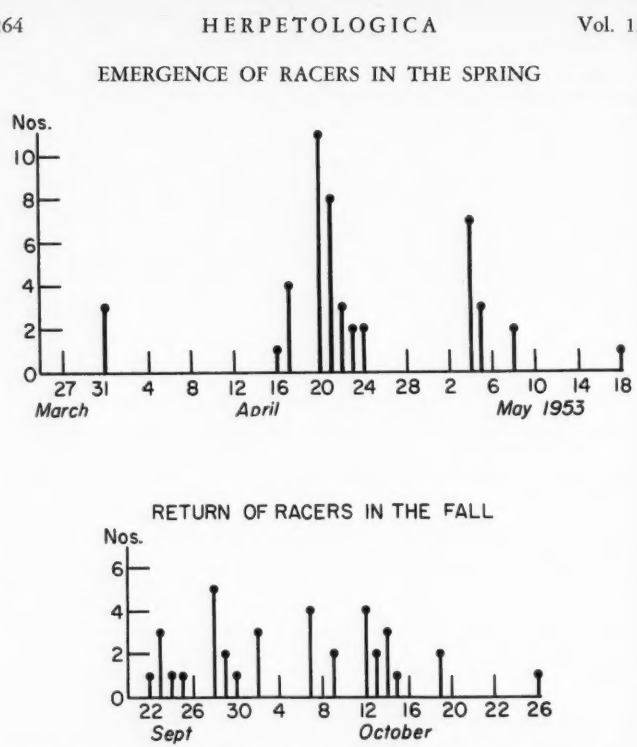

Fig. 1. Numbers of racers removed from traps on given dates during spring emergence from the den (above) and fall return (below).

During fall return:

Gopher snake: Sept. 23, 1.

Racers: Sept. 22, 1; 23, 3; 24, 1; 25, 1; 28, 5; 29, 2; 30, 1; Oct. 2, 3; 7, 4; 9, 2; 12, 4; 13, 2; 14, 3; 15, 1; 19, 2; 26, 1; Total 36.

During the spring emergence, 18 female and 31 male striped racers were captured. Of the snakes returning in the fall that may have been members of the preceding winter population, 9 were females and 20 males; the balance of 7 were not sexed. The ratio of totals, 27 females to 51 males, Fig. 2., is in harmony with findings of the sex ratio of racers at the Grantsville den given by Woodbury, et al (op. cit: 20-24) in which it was concluded that there was a preponderance of males in the dens because they lived longer than females. This trend is reversed from that found in mankind in which females tend to outlive the males.

The lengths of the racers (snout to vent measurements) are plotted in Fig. 2, which shows males, females and totals separately. This includes both the spring and fall catches, except for seven fall snakes that were not measured. This is also in harmony with the findings at the Grantsville den (op. cit. 28-40), in which it was shown that, among snakes of the same age, males will be larger than the females; or among snakes of the same length, the males will be younger than the females.

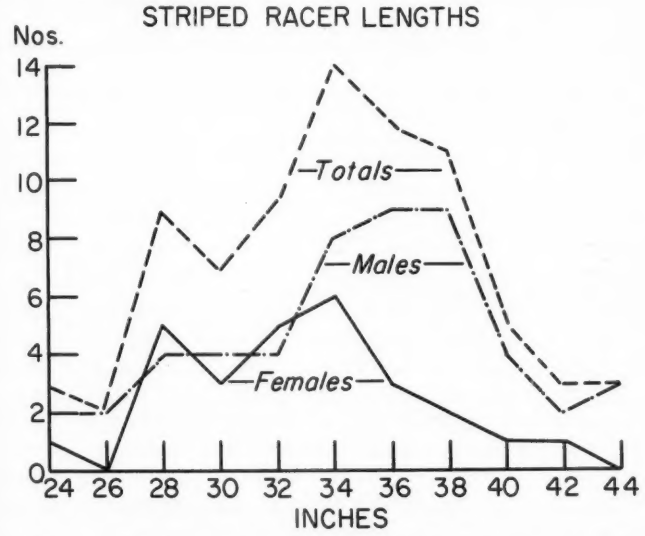

Fig. 2. Numbers of striped racers of various snout-vent lengths plotted in 2-inch classes found in the spring and fall catches.

SEARCH FOR OTHER DENS

During the summer of 1953, there were reports of snakes found around the settlement, even after the den had been emptied. This gave rise to the suspicion that there might be other dens in the neighborhood. It was reminiscent of the old claims of the pioneers that one of their problems was killing the rattlesnakes. When more young rattlesnakes were reported in the settlement in the spring of 1954 and Woodbury verified the fact that they were actually rattlesnakes and not young gopher snakes, it became practically certain that young rattlesnakes had been born in the vicinity of the settlement the preceding fall. It was then determined in consultation with Lt. Col. George E. Danald that a search for other dens would be made. Further search failed to reveal other dens even though the search was made at a time when theoretically the snakes should have been sunning themselves around the den opening. A few scattered snakes were located, including one specimen of the rare long-nosed snake, *Rhinocheilus lecontei.*

After the search failed to disclose the presence of other large dens in the vicinity, it was concluded that the snakes must be wintering in small numbers in inconspicuous places. A further search was made around the area close to the settlement on the warm morning of May 28, following a cold night. Two rattlesnakes and several gopher snakes were found.

During the fall of 1952 and the spring of 1953, reports were received from the field workers of other possible dens. On Oct. 13, 1952, a rattlesnake was found below Cane Springs on the southwest side of Cedar Mountains but no den could be located, although it is the considered opinion of the writers that there must be a wintering place in that vicinity.

A report of seeing molted snake skins led to the investigation of three different sites. An investigation of the ledges along the southwest side of Little Granite Mountain on Dec. 18 revealed several skins around some crevices in the rocks that might accommodate a small group. A similar possibility was found at the southeast base of the large outlier north of Simpson Buttes on Oct. 30, and at a small volcanic mass north of Camelback Mountain on Nov. 4, 1952. A fence and trap was set at the latter place in the spring of 1953, but because of the difficulty of fencing against sloping rocks, no snakes were captured. Two rattlesnakes were found in 1952 near an opening in a spur on the east side of Wig Mountain.. It is possible that there may be a snake den at this place.

Persistent reports of rattlesnakes being found and killed by workers near the north end of Granite Mountain led to a reconnaissance of the area on April 21, 1953. After investigating reports of workers in the area and studying the terrain, the likely place was pinpointed, but careful scouting of the area by four men failed to locate the den.

MITE STUDIES

While processing one of the racer snakes from the den, a mite, later identified as *Bdellonyssus bacoti,* was found on Parker's hand. A general survey of the snakes revealed rough spots on the otherwise smooth skin of many of them where scales were upraised by mites underneath. Careful processing for parasites of 20 striped racers and two gopher snakes revealed the presence of mites on 9 of the racers and on both gopher snakes. No mites were found on 9 rattlesnakes examined. However, when the processed racers were separated into spring and fall groups, it became apparent that mites were much more numerous in the fall. Only one mite was found on one of 7 racers captured in the spring and 143 mites on 8 of 12 snakes caught in the fall. Numbers of mites on the 8 racers were 4, 4, 5, 5, 7, 7, 44 and 67.

In addition to the external examination for ectoparasites, autopsies were conducted on 13 racers and two gopher snakes in a search for lung mites. None was found. In addition, some miscellaneous collections of snakes were processed for external mites, making totals of 20 striped racers, 6 gopher snakes and 9 rattlesnakes. The mites from these were referred to Dr. Dorald M. Allred, head of the ectoparasite work, for

identification. His identifications to date are given below. Some of these are very unusual records. Chiggers of the family Trombiculidae were sent to Dr. James M. Brennan, Rocky Mountain Laboratory, Hamilton, Montana, for confirmation. Other mites in the list below were sent to Dr. Russell W. Strandtmann, Texas Technological College, Lubbock, Texas. Of these, the feather mites of families Analgesidae and Dermoglyphidae, being such unusual records (bird mites found on snakes), were also sent to Dr. Charles D. Radford, Nuffield Laboratory, Manchester, England.

ANNOTATED LIST OF MITES

WESTERN STRIPED RACER

Acaridae; 2 hypopus nymphs, which are (according to Baker and Wharton, An Introduction to Acarology, 1952, MacMillan Co., N.Y., 465 pp., p. 333) "wandernymphs", in which the mouthparts are lacking and suckers or claspers are used in attachment to animals for dispersal.

Analgesidae . . . feather mites; 1 female, usually found on birds.

Dermoglyphidae . . . feather mites; 24 males, 51 females, usually found on birds. Each of 18 females contained one egg.

Dermanyssidae

Bdellonyssus bacoti; 1 female taken from hand of processor after handling a snake. Allred states that this is commonly found on several species of rodents here at Dugway.

Ellsworthia sp.; 1 male, 2 nymphs.

Trombiculidae . . . chiggers

Acomatacarus linsdalei; 3 larvae

Trombicula arenicola; 25 larvae

Trombicula sp. (probably *arenicola*); 8 larvae

GREAT BASIN GOPHER SNAKE

Trombiculidae . . . chiggers

Acomatacarus linsdalei; 6 larvae

Trombicula arenicola; 1 larva

Trombicula sp. (probably *arenicola*); 4 larvae

DISCUSSION

From these and previous studies of the authors, it is becoming increasingly clear that while snakes of several species congregate in large numbers (hundreds or thousands) in especially favorable underground chambers for hibernation, there must be many less favorable sites where snakes winter in smaller aggregations or perhaps even singly.

From a perusal of Fig. 2, it is quite obvious that very young snakes were not wintering in the den. Most of the snakes range in length from 28 to 38 inches. This is in harmony with the findings of Woodbury, et al (*op. cit.:* 13) in which it was shown that in general snakes first come to the den about the time they mature. Where the young snakes winter and how they find their way to the den in later years is not entirely clear although it is known that snakes are capable of following other snakes by means of the tongue and Jacobson's organ. Perhaps they locate the den by following snakes that know the way.

The pattern of emergence in the spring appears to be quite different from the pattern of return in the fall. The hibernating temperatures are

doubtless below that of the normal activity range. They are probably stimulated into emergence activity when air temperatures rise high enough in the spring to transmit an adequate temperature stimulus through the open passageway of the den, (Woodbury, et al, *op. cit.*: 15-20). Thus they tend to emerge on warm days. Cold nights and cold days retard emergence, hence it appears to be correlated with erratic spring weather. The fall pattern of return is much less irregular.

The mites on the snakes were of particular interest because of their potential ability to act as vectors of disease. The finding of feather mites on snakes suggests change of hosts from birds to reptiles, which might have taken place if a snake had eaten a bird. The role of reptiles in the transmission of disease in nature is poorly understood but will have to be investigated before the process of disease transmission in native animals can properly be evaluated. The principal problem is whether they may be susceptible to a given disease at one temperature and refractory at another.

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Anticoagulants Isotonic With Turtle Blood

By Harold M. Kaplan

Several common anticoagulants were studied for turtle blood in vitro to demonstrate that mammalian concentrations are unsuitable for tests such as sedimentation rate and cell volume in turtle blood and to show that there may be set up for the blood of a given species isotonic solutions that satisfy the major requirements of a useful anticoagulant. With the increasing work upon turtle blood, a table of isotonic concentrations should be useful.

MATERIALS AND METHODS

Blood was drawn by cardiac puncture through a cervical approach in unanesthetized turtle *(Pseudemys spp.)*. Only one blood sample was taken from a single animal, which was held (unfed) in cold torpor for approximately two weeks at 5°C. to produce fairly uniform background conditions, then adapted to room temperature before use .

Blood samples (0.9 ml.) were drawn into Wintrobe tubes containing O.1 ml. of 1 per cent heparin, and the packed red cell volume (PCV) was determined by the Wintrobe method, involving centrifugation at 1250 gravities for one-half hour. Since heparin does not significantly alter red cell size (Kracke), this value was taken as a standard. Corrections were made for the volume used.

Other 0.9 ml. samples of the same blood were drawn into Wintrobe tubes, each containing 0.1 ml. of one of the test anticoagulants. Corrections were later made for their volume.

The PCVs were determined for a range of concentrations of each anticoagulant. By graphing PCVs against concentrations of each chemical and drawing the PCV of heparinized blood as a horizontal line, the intercept of each test curve with the heparin line indicated the isotonic concentration (Hitchcock).

Since conditions governing permeability to ions vary continuously in any one cell, mean intercept values were obtained for each anticoagulant. A ten minute interval between drawing the blood sample and centrifuging it was used in all cases.

Cell size in the experimentally determined isotonic concentrations was checked in two dimensions by ocular micrometer measurements and compared for significant differences with heparin values by the Student t-test.

Cell volumes were compared with a Klett photoelectric colorimeter based on the findings of Orskov (Heilbrunn) that if the red cells shrink, less light is transmitted through the suspension and if they swell more light is transmitted. The dial was set at 50 for the standard heparin solution, with a 660 mu filter to nullify the effects of hemoglobin, and the test isotonic anticoagulants containing blood were each compared for duplication of this setting. To do this, blood was drawn into each anticoagulant in a 1 to 9 ratio, and from each suspension 0.025 ml. was taken into a Newcomer hemoglobin pipet and additional anticoagulant was drawn in to the 5.0 ml. mark. The final volumes were compared in the Klett tubes.

TABLE 1 - Anticoagulants Isosmolar and Isotonic with Turtle Blood and Isosmolar with Mammalian Blood. Volume of Blood Kept Fluid in Turtles and Mammals by 1 Ml. of Each Anticoagulant.

Anti-Coagulant	No. of determinations	Concentrations isotonic with turtle blood Mean and standard deviations		Concentrations theoretically isosmolar with turtle blood		Concentrations theoretically isosmolar with mammalian blood		Recommended ratio of isotonic anticoagulant to blood	
		Per Cent	Moles	Per Cent	Moles	Per Cent	Moles	Turtle (by experiment)	Man (from literature)
Lithium oxalate	30	0.402 ± 0.048	0.039 ± 0.005	1.156**	0.114**	1.239**	0.122**	1 to 8	1 to 9
Potassium oxalate	30	1.084 ± 0.198	0.065 ± 0.012	2.08#	0.125#	2.24#	0.135#	1 to 9	1 to 9
Sodium oxalate	34	1.376 ± 0.089	0.103 ± 0.006	1.58*	0.118*	1.70*	0.127*	1 to 9	1 to 9
Sodium fluoride	30	1.020 ± 0.289	0.243 ± 0.069	0.64*	0.152*	0.69*	0.164*	1 to 4	1 to 0.66 or 69 mg. per 10 ml.
Sodium citrate	30	1.455 ± 0.890	0.056 ± 0.034	3.40*	0.132*	3.88*	0.150*	1 to 9	1 to 9
Ammonium & potassium oxalate (1.5 to 1)	30	0.639 ± 0.210	0.046 ± .015	0.760 (0.456** / 0.304)	0.055 (0.018** / 0.038)	0.815 (0.489** / 0.326)	0.056 (0.029** / 0.026)	1 to 8	1 to 9
Heparin (sodium salt)	30	1.0	---	1.0	---	1.0	---	Fill dead space of syringe or 1 to 9	or 1 to 9 up to 1 to 99

*Computed from Hitchcock and Dougan (5). #Computed from International Critical Tables (4). **Computed from freezing point determinations.

The optimal volume of blood kept fluid by 1 ml. of each anticoagulant in isotonic concentration was determined, by trial and error.

The test anticoagulants included sodium citrate, sodium oxalate, sodium fluoride, lithium oxalate, potassium oxalate, and a mixture (1.5 to 1) of ammonium oxalate and potassium oxalate.

RESULTS

In Table 1 the mean isotonic concentrations of the anticoagulant are compared with isosmolar values for turtle and mammalian blood. Most isosmolar values were computed from known molal freezing point depressions (International Critical Tables) or from known equations (Hitchcock and Dougan). The concentrations are listed in both per cent and moles although per cent is more useful from a practical standpoint. Molar concentration is not listed for heparin since its molecular weight is uncertain. It has been assumed, although not strictly correct, that one per cent heparin is isosmolar with both turtles and mammalian bloods.

Where data were lacking, as for lithium oxalate and ammonium potassium oxalate, freezing point depressions were determined in this laboratory, "G" values computed, and from these the molalities determined which gave the same freezing point depression (-0.522°C.) as that of turtle blood (Collip) or mammalian blood (-0.56°C.). Since "G" values change with concentration, freezing points were determined on $\frac{1}{3}$ molar concentrations.

Table 1 shows the optimal volume of turtle blood kept fluid by 1 ml. of the anticoagulant. These data are compared with human values known or recomputed for approximately isotonic concentrations (Tocantins).

Upon statistically comparing the length and width of red cells in heparin and in isotonic test solutions, the resulting probabilities, p, were all greater than 0.5, indicating no significant changes in size.

All isotonic suspensions compared by the photoelectric colorimeter method had essentially the same Klett readings, indicating equal red cell volumes.

Although isotonic values are given only for turtles, isosmolar concentrations are listed for mammals as well as turtles to point up the differences and similarities among such widely different vertebrate classes.

DISCUSSION

Heparin in 1 per cent solution is a very suitable general anti coagulant for drawn turtle blood, used 1 to 9 or in a volume just sufficient to wet the dead space of the syringe. Because of its low osmotic pressure, it may exert no osmotic effect upon red cells (Biggs and Macfarlane). No anticoagulant is ideal. Heparin can interfere with determinations like sedimentation rates, prothrombin times or leucocyte counts.

Neutral salts exert an osmotic effect upon the red cells, thus making it essential to control their concentrations when preparing isotonic solutions for a given species.

The isotonic concentrations are generally lower than the isosmolar ones (Table 1). The preservation of the Donnan equilibrium may be involved. If, for example, a divalent oxalate ion enters the cell, two chloride ions leave. This decreases the cell osmotic pressure, allowing a lesser concentration of anticoagulant to be isotonic with the cell contents. There are other explanations (Davson).

Only sodium fluoride exceeded the computed isosmolar concentration. Fluoride ions may have readily penetrated the cell and blocked the exit of other ions. Fluorides decrease the outward transfer of sodium in the hyman erythrocyte (Scheer), and they can release cell ions by irritative stimulation (Heilbrunn) or influence solute concentration by altering cell metabolism. Fluorides do allow escape of potassium but this is probably accompanied by the accumulation of intermediate cell products (Davson). In consequence more fluoride would be needed extracellularly to prevent cellular swelling .

It is stated that cell size does not necessarily indicate the osmotic effect of solutes, since the changes are more likely to involve cell shape or volume (Davson). Morphologic observations as well as measurements of both cell diameters showed no alteration of the shape or size of the cells, and the photoelectric colorimeter check showed no changes in cell volume in the isotonic fluids.

SUMMARY

Common mammalian anticoagulants are generally unsuitable for lower animals, such as turtles, both in isotonic concentrations and in some instances in the amounts required to keep fluid a given volume of blood. A method, applicable to the blood of any animal, was used through which suitable concentrations and proportions of anticoagulants could be obtained for turtle blood.

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Eye Muscles of Salamanders

By William A. Hilton

In general the external muscles of the eyes of salamanders include only the four recti, two oblique and the levator and retractor bulbi muscles.

In *Taricha* larvae of about 13 mm. total length, with three toes on the front feet and rudiments of hind legs, there are indications of eye muscles on the floor of the orbit.

In adults with well developed eyes, that is in all species but some cave forms, the eye muscles vary but little.

The four recti muscles rotate the eyeball in vertical and horizontal directions at right angles to the optic axis.

M. Rectus superior. This arises from the dorsocaudal angle of the orbit to be inserted on the dorsal section of the eyeball. It is supplied by the superior branch of the third cranial nerve.

M. Rectus posterior. This arises from the region of the orbitosphenoid and is inserted on the posteriolateral surface of the eyeball. It is supplied by the sixth cranial nerve.

M. Rectus inferior. This arises back of the anterior rectus to be inserted on the ventral side of the eyeball. It is supplied by the inferior branch of the third cranial nerve.

M. Rectus anterior. This takes origin in front of the last muscle to be inserted on the anteriomedial surface of the bulbus oculi. It is supplied by the inferior branch of the oculomotor nerve.

M. Obliquus superior. This arises from the cartilago antiorbitalis. It runs posteriorly and a little towards the midline to be inserted on the anteriordorsal part of the eyeball near the fibers of the M. rectus superior. It is supplied by fibers of the fourth cranial nerve. It tends to rotate the eye about the optic axis.

M. Obliquus inferior. This arises much as the last and is inserted on the ventral side of the eyeball by a rather long insertion. It rotates the eyeball about the optic axis. It is supplied by an inferior branch of the oculomotor nerve.

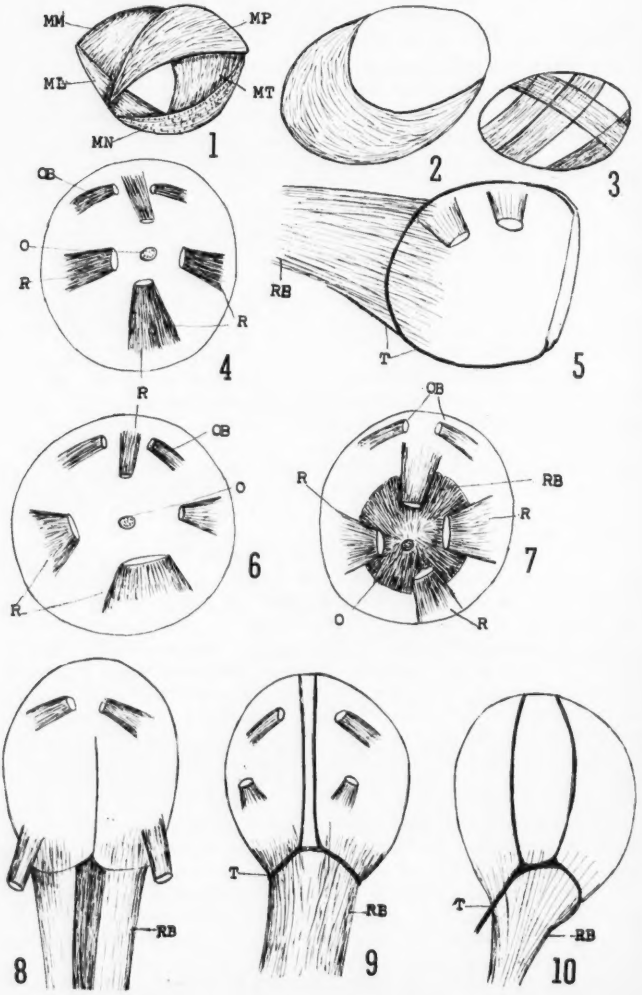
M. Retractor bulbi. This is often larger than any of the other eye muscles. It arises from the lateral process of the parasphenoid bone under the otic capsule and from the orbitosphenoid. Its fibers form a sort of cone about the median surface of the eyeball within the partial circle of the insertions of the recti muscles. Connective tissue from it joins with the eyelids, forming a broad sheet caudally, which is split in front to permit the passage of the anterior rectus muscle. It is supplied by the sixth cranial nerve.

M. Levator bulbi. This rather variable muscle contributes to the formation of the floor of the orbit and the roof of the mouth. As recognized by Luther (1914) and Francis (1937), it consists of four portions:

1. *Pars principalis.* This is the most dorsal portion. It arises from the lateral borders of the parietal, frontal and prefrontal bones of the skull. Its fibers run posteriolaterally to be inserted on the ventral side of the caudal end of the lower eyelid.

2 and 3. *Pars sagittalis.* This is attached to the palatoquadrate at the

caudal wall of the orbit and is of two parts: (a) The lateral head which passes anteromesally and is attached to the side wall of the skull just behind the pars principalis. (b) The medial head which passes anteromesally to be attached to the side wall of the skull ventral to the origin of the pars principalis across the origin of the M. retractor bulbi.



Explanation of Figures. 1. Levator bulbi muscles of one eye from above, cephalic end to the right. Right eye. Diagrammatic, from Luther. 2. Levator bulbi of *Necturus*. 3. Levator bulbi in *Ensatina*. 4. Eyeball of *Amphiuma*, posterior view. 5. Side view of the eyeball of *Taricha torosa*, showing retractor bulbi at the back and the tendon of the levator bulbi above and below. 6. Posterior view of the eye of *Necturus*. 7. Posterior view of the eyeball of *Plethodon glutinosus*, showing the retractor bulbi within the circle of recti muscles. 8. Side view of the eyeball of *Desmognathus*, showing the retractor bulbi at the back. 9. Side view of the eyeball of *Pseudotriton*, showing the retractor bulbi encircled by the tendons of the levator bulbi. 10. The same as the last, turned. ML—m.l.b. pars sagittalis; MM—m.l.b., pars sagittalis, caput mediale; MN—membrane nictitans; MP—musculus levator bulbi (m.l.b.), pars principalis; MT—m.l.b., pars transversalis; O—optic nerve; OB—oblique muscles; R—recti muscles; RB—retractor bulbi; T—tendon of retractor bulbi. (m.l.b., for musculus levator bulbi.)

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4. *Pars transversalis*. This arises from the frontal and partietal bones in front of the insertion of the last and ventral to the pars principalis. It has the most ventral fibers of all these four parts and is inserted into the lower eyelid in front of other insertions of this muscle and also on the maxilla.

All divisions of this muscle are supplied by the second branch of the trigeminus cranial nerve.

This muscle complex acts as a levator bulbi and as an accessory respiratory muscle as air is sucked in with the lowering of the gular membrane and the enlargement of the mouth cavity. It may also move the lower eyelid.

These levator bulbi divisions are not always as well defined as just described and in addition there are variations in their development and distribution. In blind forms they are lacking and in *Necturus* there is but one large muscle mass to represent them. In *Dicamptodon*, there are four or more parts but with a different arrangement than in *Salamandra* and with some of the parts poorly differentiated. In *Ambystoma*, the four divisions are easily seen but their arrangement differs a little from that of *Salamandra*, which is taken as a standard of comparison. *Rhyacotriton* has but two parts and is similar to *Plethodon* which also has two parts. I found four divisions in *Eurycea bislineata*, three in *Diemictylus viridescens* and four well marked ones in *Ensatina*.

Salamanders with well developed eyes and eyelids have more or less typical eye muscles. Cave forms with degenerate eyes have the eye muscles much reduced. In *Proteus*, there were indications of rather imperfect recti muscles but no others in the specimen examined. *Typhlomolge* had an even more degenerate condition of the eye muscles with connective tissue surrounding and supporting the eyeball. An especially strong mass of the latter joins the eye region to the well formed olfactory capsule. In *Typhlotriton* larvae and young adults in which the eyes had a moderate development, the muscles were quite well represented and in a specimen from a cave in which the individual eyes seemed no longer functional, much of the muscular apparatus of the eyeball was still present.

Some salamanders without free eyelids retain something of the retractor bulbi, but have little in the way of muscle fibers in the membrane under the eyeball.

When eyes are not well developed there may be a loss of retractor and levator bulbi and in some cases like this the oblique muscles are poorly formed or lacking.

In *Necturus* the six muscles are quite typical, but the bulbi muscles are not well developed although evident in a larva of 34 mm.

In *Cryptobranchus* adult the eye muscles are not well developed. The retractor and levator bulbi appear to be mostly connective tissue. In a larva of 36 mm, the six main muscles are well formed, the retractor bulbi is present and there are fibers in the levator bulbi. In addition a small slip, apparently from the temporal muscle, runs along the side of the eyeball to be closely associated with the inner portion of the eye region. In *Amphiuma,* I found all the eye muscles except the levator bulbi.

In all other species examined except *Pseudobranchus* and *Siren* conditions were quite typical for recti and oblique muscles as well as the retractor bulbi, but the levator bulbi differs widely with one, two, three, four or more distinct bands of muscle fibers.

In *Pseudobranchus* so far as could be seen the condition was much as in *Siren,* with the six main muscles clearly shown but no bulbi muscles present in those examined.

There are many minor variations in the eye muscles of different groups. In those where the oblique and recti muscles are developed, which includes all but the most degenerate eyes, such as the cave species of *Proteus* and *Typhlomolge,* the six muscles differ somewhat in size and position. The retractor bulbi muscles differ greatly in various species, being entirely lacking in *Necturus, Proteus, Siren, Pseudobranchus* and *Typhlomolge* and not clearly distinguishable in *Cryptobranchus* and *Amphiuma.* The levator bulbi muscles are often hard to demonstrate especially in adult *Proteus, Siren, Amphiuma, Necturus* and *Cryptobranchus* although some indications of them may be seen in *Cryptobranchus* and *Necturus* as a single sheet of fibers.

When the levator bulbi is well developed, as is the case in many species, it is not confined to the floor of the eyeball. Tendinous strands from it may surround the base of the retractor bulbi to end in the eyelids.

Muscles called levator bulbi and retractor bulbi by Norris (1908), although of the same name as those just considered, are not really eye muscles. I found the two described by him in *Siren* and *Amphiuma.* It seems to me that they are probably a part of the profundus portion of the *craniomandibularis* rather than of the *pterygoid,* because of the anterior position which they occupy.

The most imoprtant works of rather recent times on the eye muscles are by Eaton (1936, Jour. Morph., 60: 33-35) and Francis (1934, The anatomy of the salamander, Oxford Press: 49-51). I have followed the terminology of Francis.

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Notes on a Herpetological Collection From Sinaloa, Mexico

By Thomas H. Lewis and Murray L. Johnson

The Mexican State of Sinaloa is an area of intergradation of temperate desert flora and fauna with that of the arid tropics. In Sinaloa the northern limits of the thorn forest, mangrove swamps, and fig-ceiba-palm jungle overlap the southern limits of the Sonoran mesquite bush, giant cactus, and grassland-desert biota of northwestern Mexico. A collection of vertebrates made in March, 1954, included 57 amphibians and reptiles taken at the end of the dry season. Their morphology and coloration (especially insofar as they augment an understanding of their taxonomy) and associated field notes, supplemented by a few notes made in June, 1950, are reported here. All specimens are referred to by field numbers; permanent numbers are to be assigned at the College of Puget Sound, Tacoma, Washington.

Acknowledgement must be made to Dr. Hobart M. Smith and Dr. Edward H. Taylor for their assistance in preparing these notes, and for critical reading of the manuscript. Mr. Bayard Brattstrom provided access to the collections of the University of California at Los Angeles and helped in many of the identifications. All measurements are of snout-to-vent length unless otherwise indicated.

Annotated List of Species

Agalychnis alcorni Taylor. A specimen (No. 54-80) was taken as a pile of dead brush was overturned several miles north of Mazatlán on March 22, 1954. The soil was dry and dusty and the surrounding country was an expanse of sparse thorn brush. The specimen was nonetheless well hydrated and lively. The ventral surface was light yellowish-brown, becoming white on the chin and throat, and tawny orange on the thighs. The dorsal color was bright green with fine orange spots. The dorsal and ventral colors were separated by a narrow lateral white line which extended to the tips of the toes. The sides and flanks were marked with small, irregular white spots. The eye was large, black, with a vertical pupil. The head-body length was 62 mm.

The type of *Agalychnis alcorni* Taylor is from Apatzingán, Michoacán, the paratype from San Blas, Nayarit. This specimen, distinguished from *A. dacnicolor* by its truncated rostrum, represents an extension of known range of about 150 miles to the north and is a new record for Sinaloa.

Rana pipiens Schreber. Seven specimens (54-91 to 54-97) were obtained from a tule marsh around an artificial lake near the Sonora-Sinaloa border at El Carrizo.

Phyllodactylus tuberculosus lanei Smith. A male (65 mm.) was shot at Marmol (20 miles north of Mazatlán) on March 12, 1954. It was first seen on the under surface of a large arboreal termite nest, in dry thorn forest. The lizard was alert and active at midday. The interorbital scales number about 24, the enlarged tail tubercles are in six instead of eight distinct rows, and the occipitals are no larger than the other dorsal head scales.

Anolis nebulosus Wiegmann. Seven small anoles (54-8, 54-9, 54-13, 54-23, 54-24, 54-25, 54-26) were captured in the dry thorn scrub at Marmol. They were common on the ground or on tree trunks. The gular pouch was large, red, and often prominently displayed.

Ctenosaura pectinata Wiegmann. No. 54-4 (315mm.) and a DOR (54-5, 264 mm.) were taken March 12, 1954, at Mazatlan. A juvenile (54-78, 160 mm.) was taken from a burrow under a mesquite bush. It had irregular bluish areas ventrally and on the dorsum of the thighs and lower legs. Its stomach was filled with leaf fragments. Specimens seen in the field varied in the amount of bright yellow and black in the dorsal coloration. No. 54-4 had dark gray ventral coloration, becoming almost black on the chest and throat. This individual had irregular mottling of yellow on the front legs, sides and back. The head and neck were black and the tail dull gray.

Holbrookia maculata elegans Bocourt. Seven specimens which agree generally with the description of this subspecies were collected between Culiacán and Mazatlán. Nos 54-1 (male, 56 mm.) and 54-2 (male, 51 mm.) were obtained in thorn forest 30 miles south of Culiacán. Nos. 54-15 (male 52 mm.), 54-16 (female 40 mm.) and 54-21 were shot in open spaces in dense thorn scrub near Marmol. Nos. 54-81 (female 48 mm.), and 54-82 (male 51 mm.) were obtained in a dry, sun-baked open field north of Mazatlán. These specimens differ from those reported by Smith (1935, Univ. Kans. Sci. Bull. 22 (8): 119-194) from near Presidio del Mazatlán in having relatively smaller femoral pores, and in the absence, in all but one, of pink chin coloration. Our specimens showed bright pink-orange axillary color in life, with bright blue-green bordering the lateral black bars. Perhaps femoral pore size varies seasonally.

Sceloporus nelsoni Cochran. Three specimens obtained at Marmol differed in some minor characteristics from five collected later the same month in Nayarit. The northern specimens had a higher number of femoral pores (15 to 19 as contrasted with 12 to 15) and the diagonal barring of the throat characteristic of the southern specimens and of the even more southerly and closely related *Sceloporus pyrocephalus* was replaced by random distribution of blue and white scales. The dorsal color was dark brown, with only No. 54-7 showing a clearly defined light-colored dorsolateral line. The limbs were boldly barred. The black shoulder patch was confluent with a vertical black bar on the side of the neck, the bar bordered behind with yellow. The tail of the single female obtained was as compressed as those of the males. The female (54-18) measured 46 mm. and the males (54-7 and 54-20) 53 mm. and 52 mm.

Sceloporus clarki boulengeri Stejneger. These large arboreal lizards were collected at Mazatlán (7 specimens), and at El Carrizo (1 specimen) near the Sonoran border. The "cacharones" live high off the ground, mostly in thorn trees. At El Carrizo we found that they could often be driven from nests of the pack rat *(Teanopu)*, built ten to fifteen feet above the ground in mesquite trees. North of Mazatlán they inhabited thorny broad-leaf trees and acacias, and the brush along fence rows. They were seldom seen on the ground and then only when driven

from one tree to another. Some were seen 30 to 40 feet from the ground on the high limbs of large trees, and well out of shot range. Specimens on fence posts could sometimes be stunned with a light switch, limber enough to whip around the far side of the post, the collector aiming at a point where he guessed the lizard to be.

The large males were gray-brown dorsally with a pattern of light-colored chevrons beginning at the shoulders. The anterior markings were most clearly defined. The chevrons of No. 54-83, the largest specimen and a male, were pale blue. In others the blue was confined to irregular groups of single scales on the back, flanks and tail. Some of the lateral scales were blue, others a rich red brown, the two colors forming a pattern of diagonal lines passing dorsally and posteriorly. The throat and belly were brilliant blue. The mid-ventral line was black, with a band of mixed blue and black winding dorsally around the neck behind the ear. The breast and undersurfaces of the limbs and tail were white; the chin and a broad band along the mid-throat were dark dusky gray. In both sexes the forelimbs were conspicuously barred.

The females varied from pale ash gray to dark brown above with faint chevron markings of black and brown. White to partly white scales bordered the chevrons behind. The belly and throat were white with a pale bluish wash or iridescence. The throat usually bore longitudinal gray or black stripes, some of the scales showing orange coloration. The orange was repeated as a pale wash on the ventral surface of the tail. The largest females had some blue on the throat and blue in the dorsal chevron marks. Laterally, a black shoulder patch replaced the collar of the males. The sides were speckled with blue.

The largest specimen (54-83, a male) measured 107 mm. and six females averaged 77.1 mm. (range 62 to 94 mm.).

Several stomachs examined were packed with chitinous fragments, mostly beetle elytrae. Scorpions, small leaves and twigs, bits of grass, an entire large, orange-bodied dipteran, ant heads, beetle larvae, and an 8 mm. white nematode were identified.

Sceloporus horridus albiventris Smith. A male (54-6, 71 mm.) was taken in a mammal trap at Marmol, March 12, 1954. This is the northernmost record for the species. The specimen agrees in detail with an example obtained from the type locality (Tepic, Nayarit).

Urosaurus ornatus lateralis Boulenger. Ten specimens were collected (males 54-98a, 54-98b, 54-99, 54-100, 54-106 and females 54-101, 54-102, 54-103, 54-104, 54-105). These "cachoros" were taken from the thatch of adobe huts at El Carrizo, near the border of Sonora at Highway 15. They were slow-moving enough for capture by hand. In life they were dark brownish-gray dorsally with prominent black transverse bars which widened laterally, and tended to form a black lateral line. A prominent black shoulder marking, almost continuous across the nape, had an anterior projection toward the ear and a posterior projection onto the arm. The males had two large, pale blue, abdominal patches. The throat was orange or cinnamon orange laterally, and pale green medially. The remainder of the under surface was grayish-white, darker on the tail. The females differed in having a yellow or orange throat, and the remainder of the ventral surface white and unmarked. Langebartel and

Smith (1954, Herpetologica, 10:125-136) have recently discussed the relationships between this subspecies and *Urosaurus ornatus schotti* Baird in Sonora.

Urosaurus bicarinatus tuberculatus Schmidt. No. 54-3 was captured on a tree trunk 35 miles south of Culiacán, March 12, 1954. No. 54-11 and 54-14 were shot on dry, sunbaked ground in open, thorny, brush country near Marmol, 20 miles north of Mazatlán, March 15, 1954. The first two were males (42 mm. and 41mm.) with bright blue chest, the belly paler blue, and both areas bordered laterally with yellow. The throat had a median bright yellow patch. The yellow coloration faded soon after injection of preservative. The female measured 33 mm. All examples had prominent brown speckling below, heaviest on the throat, chin, lateral edges of abdomen, and tail.

Cnemidophorus sacki communis Cope. Three specimens, one obtained at Mazatlán and two at Marmol, are identical with a small series from Nayarit. Body length varied from 105 to 117 mm. The ventral coloration of the tail, fore and hind feet, and legs, was pink or orange. The bellies had a pale blue cast, with dark blue in the spaces between chin scales.

Constrictor constrictor imperator Daudin. One specimen about 5 or 6 feet long was captured on June 9, 1950. It had seized a large *Ctenosaurus* and at first was oblivious to handling. When placed in sunshine, it soon released its prey and struck repeatedly. The specimen was discovered on a low, brush-covered bank, perforated with iguana holes, bounding a shallow salt water lagoon near Mazatlán, when it suddenly halted the escape of the lizard running from my path.

Masticophis striolatus striolatus Mertens. One DOR male (54-77, 146.8 cm., tail 43.2 cm.) was found on March 22, 1954 on the highway near the Rio San Lorenzo. The stomach was empty. A shed skin from near Mazatlán was referred to this species. An adult individual observed in mid-morning was hunting above and below ground, chasing rodents from their burrows. The clearest impressions of it were its size, heavy body and relatively short tail, yellowish-gray coloration, and the speed and force with which it crashed through brush in escaping.

Masticophis bilineatus bilineatus Jan. A reddish female (565 mm., tail 250 mm.) was taken at Marmol in a dry, grassy swale surrounded by thorn forest. It appeared to be hunting lizards; the time was about 9:00 A. M. and the height of the active period of *Urosarurus* and *Cnemidophorus,* the common lizards in that habitat.

The dorsum of the head was reddish brown, becoming grayer on the nape and the anterior portion of the body. At mid-body the color again became reddish-brown, whereas over the tail it was grayer but still retained the red-brown basic color. The ventrum was white, immaculate except for two lateral rows of fine brownish dots on the anterior half of the body. The chin was speckled. Two lateral white stripes, very clear anteriorly, became obscured posteriorly. The scutellation was typical of the species. PUGET SOUND MUSEUM OF NATURAL HISTORY, COLLEGE OF PUGET SOUND, TACOMA, WASHINGTON.

Early Sexual Maturity and Longevity under Natural Conditions in the Great Plains Narrow-Mouthed Frog

By Henry S. Fitch

In my recent field study of the frog *Gastrophryne olivacea* (Hallowell) on the University of Kansas Natural History Reservation (Fitch, 1956, Univ. Kansas Publ. Mus. Nat. Hist. 8:275-306), I presented data on growth of several marked young living under natural conditions, and on the progressive size increase in successive samples taken in September and October, of the young metamorphosed in late August, 1954. On the basis of the growth rates indicated, I postulated that sexual maturity is most often attained late in the second year of life, or at an age of approximately two years. In the summer of 1955, after the above mentioned paper had gone to press, further evidence of early sexual maturity was obtained.

The sequence of events on which my findings are based began in the summer of 1951, when unusually heavy precipitation in northeastern Kansas created conditions especially favorable for the successful breeding of *Gastrophryne;* the young metamorphosed in great numbers. In both 1952 and 1953, on the other hand, drought conditions prevailed, and breeding success was at low ebb. When conditions again became favorable for breeding, with the advent of heavy rains in the summer of 1954, the population consisted chiefly of three-year-old adults surviving from the 1951 crop.

In a sample in 1954 of 67 adults mostly intercepted enroute to a breeding pond in heavy rain, size was unusually large. The twenty-four females averaged $37.4 \pm .41$ mm., and the 43 males averaged $34.3 \pm .31$ mm. Excluding the six smallest males and the five smallest females, which may have been stunted three-year-olds but probably were younger than the rest of the group, mean sizes were, females $38.2 \pm .32$, males $34.8 \pm .24$, and these sizes correspond well with the average measurements of known three-year-olds, marked at early ages and recaptured.

In 1954, the heavy rains creating conditions favorable for spawning came in the first week of June and again in the first week of August. Great numbers of young from the eggs produced at these times metamorphosed in late June and late August. Young from eggs laid in August were sampled frequently by collecting and measuring large series, in September and October. They made steady and fairly rapid growth, averaging a gain of .14 mm. per day; the last sample before hibernation, collected on October 12 to 17, averaged $22.3 \pm .09$ mm., having gained by 50 per cent over their length of approximately 15 mm. at the time of metamorphosis. June young were not sampled until early August, and by then they averaged 26.5 mm., having gained on the average approximately .25 mm. per day. Their much more rapid early growth, as compared with the August young, probably resulted from the higher midsummer temperatures under which they developed. However, in the later stages of growth, from early August to early October, their gain was much slower, averaging only .035 mm. per day. Before hibernation these older young averaged 28.1 mm., thus approaching small adult size.

In 1955 heavy rains fell in the second week of May, but temperature was still near the threshold of activity for *Gastrophryne*, and only a few reached the breeding ponds. A rain of 3.15 inches on the night of July 5, 1955, brought forth great breeding choruses. A sample of 19 calling males collected on July 8 averaged 31.7 ± .25 mm. From their small size (smallest, 29 mm.), it was obvious that these males were mostly newly matured. Only five of the 19 exceeded 32 mm. in length (33, 33.5, 34, 35, 35) and these were regarded as probably being four-year-old survivors from 1951. The remaining 14 averaged 30.8 ± .25. Females are relatively hard to find at the breeding ponds, and none was recorded on this occasion. Obviously these small adults represented the young produced in 1954. Whether both the June and August young or only the former were represented is uncertain.

These males of *Gastrophryne* thus had reached breeding maturity just over twelve months from the time they metamorphosed and thirteen months from their conception, in the case of the June brood, with corresponding figures of ten months and eleven months for the August brood if, as seems probable, these also participated. Ability to complete the life cycle in a single year may be an important survival factor in this diminutive salientian, which is dependent on irregular heavy summer rains for its breeding.

Despite the spawning activity in July 1955, no *Gastrophryne* were found metamorphosing afterward, and few young of the year were seen later in the season. In 1956 breeding at the pond on the Reservation was first noted on July 4. The chief rains in late spring and early summer that year were: 1.78 inches on April 27-28, .79 inches on May 6-7-8, 1.37 inches on May 26-29, 1.46 inches on June 4-5, 1.02 inches on June 15-18, .98 inches on June 29 and 1.09 inches on July 1-3, and 1.32 inches on the morning of July 4, which finally triggered migration to the breeding pond. Throughout the day there was a great chorus, increasing in volume after dark. Twenty males that were measured averaged 33.7 ± .35 mm., and for eight females the corresponding figure was 36.1 ± .88. These adults were thus intermediate in size between the yearlings making up most of the breeding population in 1955 and the large old adults recorded in 1954. Obviously most of them were two-year-olds.

In June 1956 Mr. W. L. Burger collected several *Gastrophryne* at a hilltop pond, and these included a marked male which had migrated there from the Reservation. This frog was approximately 1500 feet from the study area where it was captured in 1950, 1951 and 1952. Measured after preservation, it was found to be 33 mm. in length, seemingly having made no gain since 1951, but it might have shrunk slightly in the preservative. This frog was of medium-small adult size (32 mm.) when it was first captured on August 23, 1950. It may have been only one year old then, but more probably it was at least two years old. By 1956 it had therefore lived to an age of seven or eight years. Judging from the rapid rate of population turnover that occurs under natural conditions, such advanced age is attained by only an extremely small percentage of individuals.

UNIVERSITY OF KANSAS NATURAL HISTORY RESERVATION.
LAWRENCE.

Sphaerodactylus lineolatus (Reptilia: Lacertilia) in Mexico

By Edward H. Taylor

Among the herpetological collections made in Mexico by Walter Dalquest for the University of Kansas are two specimens of a small *Sphaerodactylus,* which I identify as *S. lineolatus* Lichtenstein and von Martens. These were obtained 25 kilometers southeast of Jesus Carranza, Veracruz, Mexico. They bear the KUMNH numbers 12526 and 12527. The first was collected March 31, the second, April 12, 1949.

The genus *Sphaerodactylus* is represented in Mexico only in the southeastern lowlands. Hobart M. Smith, who reviewed the Mexican forms of the genus (Herpetologica, vol. 10, 1954, pp. 21-30), recognized the following forms: *Sphaerodactylus torquatus* Strauch; *S. glaucus glaucus* Cope; *S. glaucus inornatus* Peters.

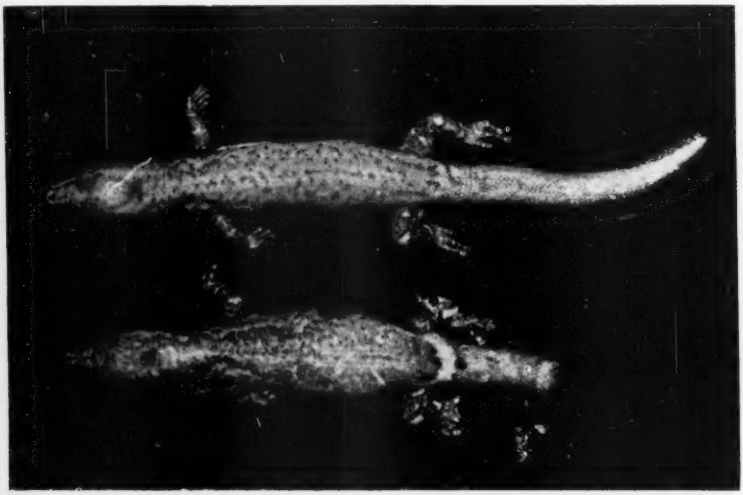


Fig. 1. *Sphaerodactylus lineolatus* Lichtenstein & von Martens. KUMNH Nos. 12526♂ and 12527♀; Jesus Carranza, Veracruz, Mexico.

The species *S. lineolatus* was included in the Smith and Taylor "Checklist and Key to the Reptiles of Mexico, Exclusive of the Snakes" with the footnote: "The species is included here on the strength of its occurrence in British Honduras . . . for although it has been cited from Mexico by numerous authors no definite record of its occurrence in that country is known to us. Its existence in Quintana Roo is virtually a certainty."

The specimens at hand agree in most details of squamation with *lineolatus* but differ markedly in coloration. There is not a trace of the heavy lineation on the head of the male such as obtains in the southern specimens from Costa Rica, and the narrow brown lines from which the species takes its name, normally present on the female body, are absent. There is a lateral stripe behind the eye that curves up to near middle of dorsum above arm. On the dorsum of both male and female there are numerous flecks of brown scattered over body and sides. There is a fairly distinct line of demarcation between the brown lateral and the lighter ventral coloration and the arms have three small irregular lighter bands or spots. The legs have a light spot on thigh, a knee-spot, and the back of thigh has a transverse line that connects with a transverse irregular band or spot about lower part of leg when leg is folded back.

The male has a well-defined series of "escutcheon scales" on the rear part of the venter, the area covered being somewhat bell-shaped with the two lower scalerows extended onto the femur, the posteriormost scales reaching distally nearly two thirds the length of femur. A total of approximately 62 scales is involved. There are two or three tiny tubercles on each side of the vent behind the insertion of the femur; the postanal region shows two elongate hemipenial swellings, but there are no postanal sacs or bones present.

In the male the tail is regenerated for most of its length. The proximal subcaudals are enlarged and rather narrow ,but on the regenerated part there are transversely widened scales, very unlike the original subcaudals; the other caudal scales are not arranged in transversely diagonal rows.

The female has a median row of enlarged subcaudals, the alternating scales being a little wider and larger than the others; ventrolaterally there is a longitudinal unpigmented light line bordering the lateral fawn-brown coloration.

The snout is distinctly elongate, the scales smooth, rounded, and definitely unkeeled, the dorsal body granules juxtaposed, definitely keeled, and elevated. There are about 54 dorsal longitudinal rows of granules, whereas the larger smooth cycloid scales on the venter number about twenty, the outer series being smaller than the more mesial ones.

Since the type locality is in Panamá it is presumed that the distribution is continuous between Mexico and Panamá. However it is not impossible that the form has actually been "imported" by man. A review of *Sphaerodactylus lineolatus* when sufficient material is available from Mexico and the Central American countries may show the presence of subspecific forms worthy of nomenclatural recognition.

DEPT. OF ZOOLOGY, UNIVERSITY OF KANSAS.

Experimental Hybridization Between Two North American Tree Frogs

By Kenneth L. Gosner

Hybridization between *Hyla crucifer* Wied, and *Pseudacris triseriata* (Le Conte), has been reported by Blair* (1941, Proc. Nat. Acad. Sci., 27 : 14-17), but no other attempts to cross *H. crucifer* with any form of *Pseudacris nigrita* appear to have been recorded. This problem is of interest with regard to the efficacy of isolating mechanisms since the two species occur sympatrically in many parts of the eastern United States and often occupy the same breeding pools. The adults are of approximately equal size, and the breeding seasons of the two forms overlap or are wholly synchronous. Another point of interest involves the development of pigmentary patterns, especially because the species in question represent two extremes of pattern development in the *Hylidae*. The present paper, describing the results of experiments made in the spring of 1955 with New Jersey material, confirms Blair's conclusions and adds a few new observations.

Hyla crucifer crucifer occurs throughout New Jersey, occupying a wide variety of habitats. *Pseudacris nigrita feriarum* occurs in more or less isolated, somewhat weakly developed populations in Sussex, Warren, and part of Hunterdon counties, and *Pseudacris nigrita kalmi* (Harper, 1955 Nat. Hist. Misc., 150:1-6 is found on the Coastal Plain and in the Triassic lowlands. The *Pseudacris* forms are more selective with regard to choice of breeding habitat, but, wherever they occur, *H. crucifer* is a potential associate in the breeding season; numerous observations have shown that such association actually occurs. Mixed-species amplexus takes place readily when sexually active specimens of these species are confined in the same aquaria but such behavior appears to be of rare occurrence in the field. The absence of mixed amplexus in the field (or observations thereof) might be attributed to the existence of "female courtship" behavior in these forms (Jameson, Syst. Zool., 4:105-119, 1955).

Spawning has been observed in the laboratory and the movements and responses characteristic of the behavior patterns of the two species are very similar. Attempts to obtain hybrids by natural amplexus were, in this study, unsuccessful despite the fact that several pairs clasped for periods in excess of 48 hours. The normal behavioral responses associated with spawning were observed in only one case. In several instances the female laid eggs out of water and on other occasions no eggs were deposited while the male and female were in amplexus. Since a primary goal of the present study was to secure hybrids for pattern study,

*Blair's *"triseriata"* specimens from Indiana were from an intergrade area between *P. n. feriarum* and *P.n. triseriata* according to Smith and Smith (1952).

I wish to thank Dr. Robert F. Inger of the Chicago Natural History Museum, Mr. Neil D. Richmond of the Carnegie Museum, and Dr. Albert Schwartz of the Charleston Museum for the loan of specimens of *Pseudacris* examined in connection with this project.

standard procedures for obtaining fertilization artificially were used and all the hybrids were produced by this method.

Forty-four hybrids from five crosses were raised through metamorphosis. The parents were preserved immediately following fertilization, and the young in the later stages of metamorphosis; all of the specimens are in the collection of the Newark Museum. A list of the specimens follows with the catalog numbers preceded by the letter "Z," and enclosed in parenthesis; the female parent is listed first in each experiment.

Experiment H6: 18 hybrids (Z55.348), *P. n. kalmi* (Z55.30) from Great Piece Swamp, Essex County, X *H. c. crucifer* (Z55.48) from Caldwell Township, Essex County; *Experiment H7:* 7 hybrids (Z55.344), *P. n. kalmi* (Z55.32) from Cape May Court House, Cape May County, X *H. c. crucifer (Z55.46)* from Hatfield Swamp, Essex County; *Experiment H9*: 1 hybrid (Z55.345), *H. c. crucifer* (Z55.312) from Lincoln Park, Essex County, X *P. n. kalmi* (Z55.50), from the same locality; *Experiment H12*: 7 hybrids (Z55.356), *H. c. crucifer* (Z55.332) from Lincoln Park, Essex County, X *P. n. kalmi* (Z55.73) from the same locality; *Experiment H14*: 11 hybrids (Z55.347), *P. n. feriarum* (Z55.62), from Swartswood Lake, Sussex County, X *H. c. crucifer* (Z55.188) from "northern New Jersey".

The female of Experiment H7 is a typical Coastal Plain specimen of *kalmi;* the *Pseudacris* in experiments H6, 9, and 12 were from the Triassic lowlands population which is somewhat more variable and includes individuals that show indications of possible intergradation with *feriarum.* The *Pseudacris* female in Experiment H14 is a typical *feriarum* specimen.

The females used in these experiments had in most cases already ovulated and the eggs were dissected from the oviducts into sperm suspensions.

In experiments H6 and H7 the eggs were divided and part of them fertilized with sperm from males conspecific with the females. This was done as a partial check on the viability of the eggs. Although it was not practical to follow this procedure in all of the crosses, the results with regard to Experiment H7 are of interest. In this test both the conspecific and hybrid matings resulted in cleavage of better than 90% of the available eggs. Whereas nearly all of the embryos (90% or more) from the conspecific mating hatched normally, only about 10% of the hybrids hatched and about 1% were normal.

The proportion of eggs showing cleavage varied from less than 1% in Experiment H9 (*H. crucifer* female parent) to more than 90% in experiments H7 and H12. Experiment H12 also involved a female *H. crucifer* parent; slightly more than 20% (12 individuals) of the embryos in this cross survived through hatching but only 7 of these (12% of total) were normal and only 5 transformed. The proportion of hatchlings that was carried through metamorphosis in Experiment H14 was 100% and in H6, more than 75%. Mortality occurred at various embryonic and early larval stages. When the hybrids reached the hatchling stages without apparent morphological defects there was usually a good expectation that they could be carried through metamorphosis satisfactorily.

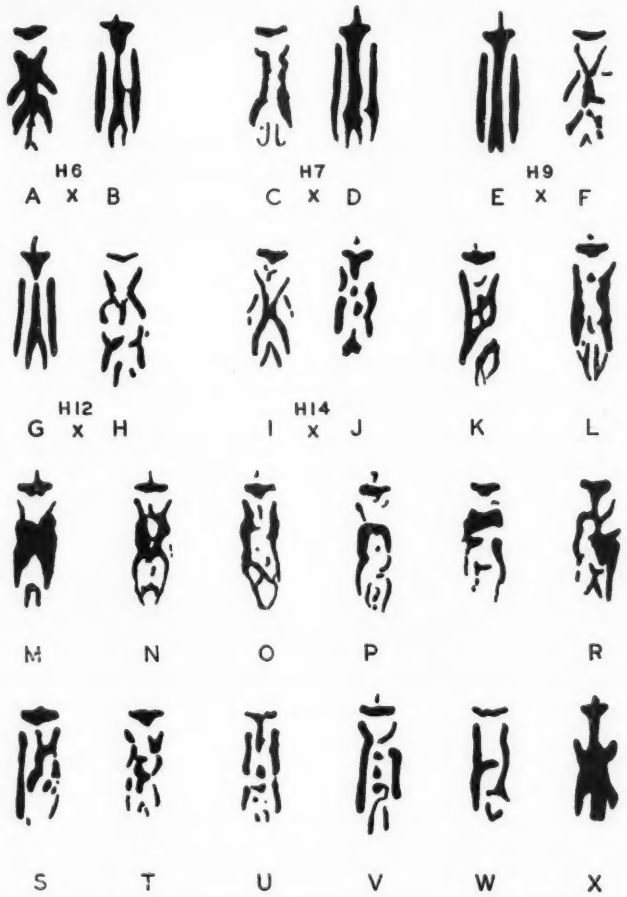


Fig. 1 Dorsal pigmentary patterns: A-J, *Pseudacris* and *Hyla c. crucifer* parents, the female is at the right in each pair; B, D, E, G are *P. n. kalmi,* J is *P. n. feriarum,* A, C, F, H, I, are *H. c. crucifer;* K-W are hybrids, K-O from Experiment H6, P-S from Experiment H7,T from Experiment H9, U from Experiment H12, and V-W from Experiment H14; X is an aberrant *P. n. kalmi* adult male.

Developmental rates of embryos and larvae of the two parent species and of the majority of hybrids were approximately equal. The time from first cleavage to hatching in the hybrids varied from 91-118 hours at 18°-20° C. The larval period varied from 28-54 days although most individuals transformed in 30-35 days. Blair gave 71-186 days as the larval period for his hybrids but the longer period of development and the higher mortality rate in Blair's larvae may have been due to crowding.

Hybrids from a *H. crucifer* female appear to be less viable than in the complementary cross and the percentage of eggs cleaving is also lower. Although none of the transformed young in the present study were kept for more than a few weeks, they fed readily on aphids and other small insects and did not exhibit any morphological or behavioral abnormalities.

In both *Pseudacris* and *H. crucifer* the dorsal pattern of the newly transformed young is typical of that of the adult. The pattern begins to appear shortly before the young leave the water and a comparison of large numbers of transforming and adult individuals of both species supports the view that no basic reorganization of dorsal pattern elements need be expected during maturation.

The hybrid patterns are extremely variable and, in some respects, are intermediate between those of the two parent species. Fig. 1 shows the dorsal markings of the parents and of a representative selection of hybrids. The *Pseudacris* patterns in Fig. 1, B, D, E, and G are typical of adult *kalmi* while Fig. 1, J shows a typical *feriarum*. The patterns of the *H. crucifer* parents are representative of the variable dorsal markings of this species.

Striped and cruciform-type patterns, although superficially dissimilar, appear to be genetically related and both forms occur repeatedly in the *Hylidae*. The effect on pattern formation of hybridization between species showing these pattern types is therefore of some interest. The following resume of observations on striped patterns is pertinent to the present discussion. *Pseudacris brachyphona* shows a variable development of dorsal markings that appears to be intermediate, in many instances, between the striped and cruciform types. Slightly less than half of a series of 47 adults that were examined had a basic pattern of two dorsolateral stripes; the remainder of the sample had the stripes joined in one way or another. Some of these variations closely resemble the pigmentary patterns of the *crucifer* x *kalmi* hybrids. Variant specimens of *H. crucifer* (Fig. 1,C) and *Hyla versicolor*, (species with normally cruciform patterns), may have the dorsal pattern dominated by a pair of dorsolateral stripes. While the tendency to form three dorsal stripes is characteristic of a number of forms of *Pseudacris*, the dorsolaterals are frequently more stable than the middorsal, *e.g.* in *P. n. septentrionalis*, *P. streckeri*, and *P. n. clarki*. This is also true of *P. n. triseriata* and of the two New Jersey forms. The relative stability of the three stripes is revealed by the frequency with which they are fragmented in typical population samples. Thus, an examination of 81 *kalmi* from the New Jersey Coastal Plain

shows the middorsal stripe broken in 12.5% of the specimens whereas the dorsolaterals were fragmented in only 2.5%. In *feriarum*, which normally has a pattern of broken stripes or scattered spots, the middorsal stripe is broken in 92% while the dorsolateral stripes are incomplete in about 62%; these figures are based on 74 specimens from South Carolina (Cherokee, Oconee, and York counties) and approximately the same values were obtained for the 44 New Jersey *feriarum* in the Newark Museum collection.

In view of the observations on striped patterns, very briefly outlined above, it is not surprising to find that the formation of a pair of dorsolateral stripes is the most prominent tendency in pattern formation among hybrids between *H. crucifer* and the two New Jersey subspecies of *P. nigrita*. The inclination to form a third, middorsal stripe is indicated in a small percentage of the specimens. The dorsolateral stripes are usually joined by dark bars or crossbands that are extremely variable in form. In this connection it may be mentioned that the middorsal and dorsolateral stripes of *kalmi* (and also *P. n. triseriata*) may be connected, usually by only a single bar; variants of this type are found in about 10-15% of the specimens in large samples of New Jersey *kalmi* (see Fig. 1 B).

Blair observed that certain collected specimens from Indiana show patterns suggestive of hybridization but he concluded that occasional hybridization would have little effect on the population characteristics of these two species.

A careful examination of approximately 180 specimens each of *kalmi* and *crucifer* from New Jersey has failed to reveal any very convincing evidence that hybrid specimens might be present in these two large samples. In this connection I would call attention to the *Pseudacris* shown in Fig. 1X which has an aberrant dorsal pattern. This specimen, a male from Green Village, Morris County, was mated with a *Pseudacris n. kalmi* female from Lincoln Park, Essex County, and twenty offspring were raised through metamorphosis. The young all resemble *kalmi* and show no evidence of hybrid ancestry. As a group the offspring indicate certain aberrant trends probably derived from the male parent. Thus 35% of the individuals (compared to 10-15% in the general population), have a narrow bar uniting the middorsal stripe with one of the dorsolaterals and two of the specimens have a complete crossbar uniting all three stripes. In 85% of these offspring one or both of the dorsolaterals are shortened, leaving an anterior, elongate fragment free from the remainder of the stripe.

The question of the importance of possible "female courtship" behavior as an isolating mechanism separating these two species in the breeding season is a problem for further investigation.

NEWARK MUSEUM, NEWARK, NEW JERSEY

A SIMPLE AND PRACTICAL METHOD OF ARTIFICIALLY INCUBATING REPTILE EGGS.—In the course of the writer's ecological studies on the ornate box turtle, *Terrapene ornata* (Agassiz), it has been necessary to collect and incubate large numbers of eggs for the purpose of obtaining hatchlings and to study rate of development under various conditions of temperature and humidity. Experimentation with various media, including earth, sand, paper towels, and *Sphagnum* moss, revealed that cotton was best.

Eggs collected in the field are brought to the laboratory in damp cloth sacks. When necessary, soil and other foreign material are removed from the shells with running water and a soft brush. Eggs are obtained also from the cages of captive females, or from the oviducts of gravid females. Each clutch is identified by a waterproof label and each egg is numbered with a soft pencil. The eggs are then placed between two layers of moist, absorbent cotton in glass containers. The cotton is molded with the hands to form pads approximately one-half inch thick which fit snugly into the container. A finger bowl four inches in diameter at the top and one and three-quarter inches deep was always large enough to accommodate clutches of *Terrapene ornata* eggs. Molds developed less frequently when a shallow container was used.

The top layer of moist cotton is tamped down around the eggs and the dishes are stored. A maximum-minimum thermometer is placed nearby to record temperatures during incubation. Moisture can be controlled by sprinkling water over the cotton.

The eggs of *Chrysemys picta bellii, Coluber constrictor flaviventris, Eumeces obsoletus,* and *Crotaphytus c. collaris* also have been incubated by this method, with nearly one hundred percent success. The chief advantages of the system are as follows: egg shells remain clean and translucent during incubation, making it possible to examine the embryo by transmitted light and to measure roughly its growth; the eggs may be accurately weighed and measured without the incubation medium adhering to them; the numbers on the eggs make it possible to study the development of each egg separately; each clutch of eggs may be easily examined or treated experimentally (say, removed to a refrigerator or an incubator) without disturbing other clutches of eggs; hatchlings are unencumbered by dirt or sand and can be measured and weighed easily without washing. If the cotton is allowed to dry, the legs of the hatchlings may become entangled with it. Paper towels have many of the same advantages as cotton for a medium of incubation, but the towels dry out more quickly and are more likely to become moldy.—*John M. Legler, Museum of Natural History, University of Kansas, Lawrence, Kansas.*

DISPERSAL AND MINIMUM HABITAT OF THE LEOPARD FROG.—A small *Rana pipiens* Schreber appeared at a small, newly constructed garden pool in mid-August, 1956, 3.5 miles north of Travelers Rest, Greenville Co., South Carolina. The nearest water or damp areas were 800 feet and 1200 feet away, separated from the pool by dry, weedy fields and pine woods. This individual has remained for a month, so that the isolated pool (area: 9 sq. ft.; depth: 5 in.) and surrounding shrubs may meet its habitat requirements.—*George F. Townes, 209 Masonic Bldg., Greenville, S.C.*

Sceloporus undulatus erythrocheilus ssp. nov. (Reptilia, Iguanidae), from Colorado

By T. Paul Maslin

Smith (1946), in his Handbook of Lizards, describes the range of *Sceloporus undulatus elongatus* Stejneger in these words: "*Range.* Colorado, except northeastern corner, and extreme south-central Wyoming; extreme western Oklahoma Panhandle; eastern half of Utah; northeastern corner of Arizona and northwestern corner of New Mexico. Type locality—Moa Ave, Painted Desert, Arizona." Subsequent intensive collecting in Colorado has demonstrated that these lizards rarely occur above 9,000 feet and usually not above 7,000, although latitudinal differences are extensive. Because of the high mountain masses down the west central region of Colorado and Wyoming *S. u. elongatus* (*in sensu* Smith 1946) is split into two populations which are not in contact with each other. Both of these populations intergrade with *Sceloporus undulatus tristichus* Cope to the south in New Mexico but remain separate from each other throughout Colorado and Wyoming. At my suggestion Stebbins (1954) indicated this hiatus in his account of the species *S. undulatus* and assigned the eastern Colorado and Wyoming population to *S. u. tristichus*. Further study of this taxon, however, shows that it is different from *tristichus* and should be recognized as a distinct subspecies.

Sceloporus undulatus erythrocheilus ssp. nov.

Diagnosis. Lips and adjacent scales of males during breeding season a bright rust red. Gular patches in contact with each other on throat in both males and females. Circumabdominal scale rows at level of greatest girth: males, 47.96 ± .18, S. D. 2.14 ± .13; females, 48.00 ± .22, S. D. 2.37 ± .16. Median dorsal scales from interparietal to level opposite posterior face of hind legs; males, 45.73 ± .16, S. D. 1.83 ± 11; females 46.74 ± .18, S. D. 1.98 ± 13. Dorsolateral light stripes weakly developed and discontinuous, or lacking.

Type and specimens examined:—Holotype: U.S.N.M. No. 00000 (Univ. of Colo. Mus. No. 5061), adult male from Colorado, Las Animas Co., 19 mi. E. Model, Purgatoire River; collected 17 Sept., 1949 by T. Paul Maslin and H. Adair Fehlmann.

Specimens examined including type: All specimens are in the University of Colorado Museum.

Colorado: Alamosa Co., 3939, 7222-7223; Baca Co., 2951-2989, 3159-3160, 7224; Bent Co., 5032; Boulder Co., 211, 434, 632, 1042, 2879-2880, 3431-3433, 5656-5658, 6814-6819, 7131, 7203-7211; Conejos Co., 3899-3938; Costilla Co., 3940-3964, 6989; Elbert Co., 7212-7221; El Paso Co., 2229; Fremont Co., 3180-3181, 5660-5694; Huerfano Co., 1301-1302, 2231-2233, 5965-5974, 5983-5986, 5988-5993, 7078; Larimer Co., 2223-2224, 2552, 5217-5218, 5655, 6742-6744, 7197-7201; Las Animas Co., 1288-1291, 1293-1995, 1297-1300, 2990-3017, 5033-5117, 5211-5216, 7079-7100, 7102-7103; Otero Co., 1289, 4991-5031, 6820; Pueblo Co., 2230, 2623-2652, 3965-3967, 4982-4990, 5976-5982.

New Mexico: Colfax Co., 7053-7063; Santa Fe Co., 6639-6653, 7050-7052.

Wyoming: Converse Co., 6983, 7194-7196.

Range:—From Converse Co., Wyoming, south along the eastern foothills of the Rocky Mountains and the Sangre de Cristo Range to Santa Fe, New Mexico. East in the high mesa country of southern Colorado and northern New Mexico as far as extreme western Oklahoma. Also present in the San Luis Valley of Colorado.

Description of the type. An adult male measuring 66 mm. from tip of snout to posterior edge of preanal fold. Circumabdominal scales at point of greatest girth 47; median scales from interparietal to level opposite posterior face of thighs 46; femoral pores 19-18, medial pores of two series separated by 6 scales.

Crown of head and middorsal region dark beige gray with indistinct mottlings; lateral to this area an indistinct light line, interrupted regularly by the undulant, dark, dorsolateral marks typical of the species; lateral to this light area a much darker dusky band 4 scales wide from neck to inguina and on above hind legs for a short distance on lateral face of tail, there fading away; this dusky band faintly subtended by a light, lateral, blue line between legs; ventral to this line a second dusky band immediately above the large, black-bordered, blue flank patch; this second dusky band narrower and marked by scattered isolated lighter scales. Ventrolateral flank patches separated medially by about six scales.

A narrow, dark, postocular streak starting on lower eyelid, extending above ear to dorsolateral dusky band; a second less distinct, narrow, dark stripe, extending from last supralabial below ear, and to a large, black shoulder patch; labials, supraoculars, mentals, and intermandibular scales brick red in life; blue gular patches in contact medially, margined posteriorly with black, this black margin laterally joining the black shoulder patch; anteriorly, discontinuous gray, mottled stripes radiating out from the gular patch towards labials; chest, abdomen, ventral surface of thighs, and preanal scales mottled and spotted with gray; an indistinct and discontinuous ventro-median gray stripe from gular patch to a point between femoral pores.

Tail white below, pale brown above, crossed by numerous darker bands; fingers and toes similarly colored.

Variation. The material at hand was collected with unquestionable bias; generally large specimens were collected and obviously juvenile specimens only occasionally sampled. In spite of this when plotted for length a normal distribution pattern was apparent. The mean length from snout to vent of males is 62.85 ± .29, S. D. 4.19 ± .20 mm, and the mean length of females 65.67 ± .35, S. D. 4.58 ± .29 mm. The largest male and female actually collected both measured 77 mm. Specimens shorter than 46 mm. were not included in the tabulation.

The left and right femoral pore counts were treated together thus nearly doubling the counts available. The mean for males is 17.21 ± .08, S. D. 1.29 ± .07, and females 17.07 ± .09, S. D. 1.37 ± .09. The mean number of scales lying between the median most pore of each leg series were as follows: ± males 5.92 ± .06, S. D. .71 ± .04; females 6.43 ± .08, S. D. .81 ± .05.

The color pattern of males or females when considered separately vary primarily in the intensity of the color pattern and the degree of deposition of melanin so that some specimens of either sex are extremely pale and others strikingly dark with bold black markings. Chromatic sexual dimorphism is well developed in this race. The most striking difference between the sexes in the breeding season is the lack in females of the red markings on the lips and adjacent scales. Dorsally females have a more contrasting pattern than the males. The undulant dorsolateral markings are much darker and the ground color somewhat paler. The minute granular gray speckling which often obscures the pattern in males is never so well developed in females. The lateral dusky bands in females are much paler and the lower band more obviously speckled with lighter scales, but not nearly so markedly as in the adjacent subspecies *S. u. garmani*. The blue flank markings of females lack a black border and tend to fade rather gradually into the white median abdominal area, nor are they as brilliant a blue as in males. The gular patches of females also lack the black border apparent in males; but the discontinuous radiating gray lines of the intermandibular region are present. Gray speckling and mottling is occasionally present in females particularly in the pectoral region; and the ventro-median gray line is also occasionally found. Specimens near the mean in length are the most clearly marked in both sexes.

The gular patches are absent or poorly developed in juvenile specimens and rarely are in contact with each other. They increase in size with age and finally touch in 99.2% of the males over 50 mm. in length from snout to vent. The expansion of the gular patches in females is slower and never so complete as in males. Only in 70.9% of the females do the patches actually touch in specimens over 50 mm. in length.

Habitat. This race is exclusively a rock inhabiting form. Cliffs, rim rock along mesas and buttes, outcroppings, and exposed rocky areas in stream beds of arroyos and canyons are the usual haunts. Abandoned houses and outbuildings and heaps of trash are occasionally utilized especially if they are adjacent to rock. Large expanses of unbroken rock are avoided, but when fissures and brush occur in or adjacent to such expanses specimens may be found. Nearby brush and trees seem desirable but not essential; but when an outcropping in a canyon floor is completely covered by such growth the area is avoided.

Relationships. *S. u. erythrocheilus* differs from all other races of this species by the presence of red lips and adjacent scales during the breeding season. It intergrades with *S. u. tristichus* to the south from which it differs in having its gular patches in contact, being of greater size, having a much higher dorsal scale count, and in having a slightly higher circumabdominal scale count. As far as I am aware it does not intergrade with *S. u. garmani* to the east. The two races approach within a few miles of each other but have radically different habitats. *S. u. garmani* is a sand and brush lizard, much smaller in size and possesses brilliant, con-

tinuous dorsolateral, light stripes. Intergradation may occur in the Oklahoma Panhandle, but as yet no intergrading forms have been collected. *S. u. erythrocheilus* most closely resembles *S. u. elongatus* of the western side of the Rocky Mountains with which, however, it does not intergrade. In the usual counts and measurements and in size the two races are very similar. They differ primarily in color pattern; in *S. u. elongatus* the gular patches do not touch. In spite of the isolation of these two forms I am inclined to consider *S. u. elongatus* as the most closely related race.

I wish to acknowledge the financial aid rendered me by the University of Colorado Council on Research and Creative Work. This aid made possible numerous collecting trips which otherwise could not have been undertaken.

UNIVERSITY OF COLORADO MUSEUM, BOULDER

THE SPADEFOOT TOAD IN MARYLAND*.—Recent collections of the Spadefoot toad, *Scaphiopus holbrooki holbrooki* Harlan, in Maryland and on the Delmarva Peninsula extend notably its known range in this region.

West of Chesapeake Bay, Mansueti (1947, Md. Jour. Nat. Hist. 17(1): 7-9, 12-14) cites Prince Georges and Calvert Counties. Cooper (1953, Md. Naturalist 23(3-4): 90-100) lists it from Anne Arundel County. It has also been collected in St. Marys and Charles Counties, as well as from the District of Columbia, Hay (1902, Proc. Biol. Soc. Wash. 15: 128), where a single record exists, even though recent collections do not include it there.

The following collections by the author and by Ralph Daffin are additions to the known distribution of this toad in Calvert and Anne Arundel Counties.

Calvert Co.: Cove Point (July 22, 1956; Reed 1081); Huntington (July 22, 1956; Reed 1073). *Anne Arundel Co.*: W. Owings (July 22, 1956; Reed 1077-80); Edgewater (July 21, 1956; Daffin 541); 1.5 mi. S. Rt. US 50, on Rt. 2, near Edgewater (July 21, 1956; Daffin 543); along Rt. US 50 at Rt. Md 2, near Annapolis (July 21, 1956; Daffin 544).

On the Delmarva Peninsula, Mansueti (1947, *l.c.*) and Cooper (1953, *l.c.*) gave Caroline, Talbot and Wicomico Counties. Conant (1945, Publ. Soc. Nat. Hist. Delaware, :3) listed it from New Castle, Kent and Sussex Counties, Delaware, Caroline and Wicomico Counties, Maryland and Accomac County, Virginia.

The following collections by the author are either new county records or additions to the known distribution of this toad on the Delmarva Peninsula.

MARYLAND: *Worcester Co.*: NE Pocomoke City in the Pocomoke State Forest (July 9, 1956; Reed 1103-1104); *Somerset Co.*: just N Pocomoke City (July 9, 1956; Reed 1126); *Caroline Co.*: Denton (McCauley; USNM-104406); near Tuckahoe River (Aug. 16, 1954; Reed 938-939); *Dorchester Co.*: region of Sharptown and Eldorado (Aug. 16, 1954; Reed). Denton and the Tuckahoe River localities are on the

*Contr. to the Herpetology of Md. and Delmarva: 3.

Choptank River drainage and Sharptown and Eldorado are on the Nanticoke River drainage.

DELAWARE: *Sussex Co.*: Bridgeville (Aug. 16, 1954; Reed 937), which is also on the Nanticoke River drainage.

VIRGINIA: *Accomac Co.*: woods in region of Oak Hall and New Church (July 9, 1956; Reed), which is south of the Pocomoke River drainage.

Therefore, for Maryland and the Delmarva Peninsula the range of the Eastern Spadefoot Toad is from New Castle County, Delaware, southward through Worcester County, Maryland, to Accomac County, Virginia and westward on the Peninsula to Somerset, Wicomico and Dorchester Counties and northward to Talbot and Caroline Counties. West of the Chesapeake Bay it ranges from southern Maryland in St. Marys and Charles Counties northward through Calvert and Prince Georges Counties to central Anne Arundel County and the District of Columbia. In Frederick County which is in the Piedmont and Blue Ridge regions there are several coastal recesses near Thurmont and Emmitsburg where it has been reported and collected. Other such coastal recesses occur in Montgomery and Baltimore Counties, especially in the regions of Sugar Loaf Mt. in the former county and along the Big Gunpowder Falls in the Glen Arm to Towson region in the latter county. These recesses are the only localities in Maryland where certain coastal plants are to be found off the Coastal Plain.

The general range for the Eastern Spadefoot Toad is given in the 6th edition of the Checklist of North American Amphibians and Reptiles by K. Schmidt (1953) as Massachusetts to Florida, west to Louisiana, eastern Texas and Arkansas, and northward in the midwest to West Virginia, southern Ohio, Indiana and Illinois. Wright & Wright, in Handbook of Frogs and Toads, map 7, page 124, indicate the distribution in our region as the Delmarva Peninsula and west of the Chesapeake Bay on the coastal plain in southern Maryland northward through the Piedmont Region of central Maryland into central Pennsylvania.—*Clyde F. Reed, 10105 Harford Rd., Baltimore 34, Md.*

NEW RECORDS FOR THE EASTERN SPADEFOOT TOAD IN MARYLAND.—Mansueti (Md., Jour. Nat. Hist. Soc. Md., Vol XVII, 1947, pp. 7-14) summarized the distribution of the eastern spadefoot toad, *Scaphiopus holbrooki holbrooki* Harlan in Maryland, listing it from Caroline, Talbot and Wicomico Counties, on the outer Coastal Plain and Calvert and Prince Georges Counties and the District of Columbia on the inner Coastal Plain. This note reports additional county records. The institutions and private collections with their catalogue abbreviations as used herein are as follows: Natural History Society of Maryland (NHSM); Museum of Natural History University of Illinois (MNHUI); Chesapeake Biological Laboratory (CBL); Robert S. Simmons (RSS); Charles J. Stine (CJS) and James A. Fowler (JAF).

Anne Arundel County (southern Maryland on the inner Coastal Plain).

1. NHSM A 1782, Briarcliff. A single specimen dug from a garden Apr. 20, 1947.

2. NHSM A 2003, Joyce Lane. An adult DOR, July 3, 1948, Mr. John Cooper.

3. NHSM (no number) and RSS 100, Priest Bridge. Eggs, tadpoles and toadlets collected in sand-gravel pits June 29, 1947, by Mr. Romeo Mansueti. Breeding colonies were found at this station during hurricane rains on Aug. 12, 1955, by Dr. Robert Simmons.

4. CBL (no number) and RSS 97, Benfield. Many DOR adults following a heavy rain June 23, 1950, by Mr. John Cooper and Mr. Joseph Gentile. A breeding colony found at this station in a transient roadside pond during hurricane rains on Aug. 12, 1955, by Dr. Robert Simmons.

5. RSS 98, Glen Burnie. A breeding colony found in a transient pond during hurricane rains on Aug. 12, 1955, by Dr. Robert Simmons.

6. CJS 310 and JAF 1386, Annapolis. Numerous recently transformed toadlets found on a lawn on Sept. 3, 1955, by Dr. William Bayliff.

Charles County (southern Maryland on the inner Coastal Plain).

1. CBL (no number), Cedarville State Forest. A large number of tadpoles found in a sand-gravel pit pond and identified by mouth parts. Collected Aug. 24, 1955, by Mr. Romeo Mansueti.

Kent County (Del-Mar-Va peninsula on the outer Coastal Plain).

1. CJS 7-10 and RSS 19, Massey. A large breeding colony found in a cut-over corn field after a heavy rain April 1, 1952, by Dr. Robert Simmons and Dr. Charles Stine.

Somerset County (Del-Mar-Va peninsula on the outer Coastal Plain).

1. CJS 322, Tindlys Chapel. A juvenile and an adult collected on a hard-top road at night opposite a corn field on Aug. 28, 1956, by Mr. Howard Campbell. This record presently represents the southernmost station for this species in Maryland.

Worchester County (Del-Mar-Va peninsula on the outer Coastal Plain).

1. CJS 310 and JAF 1384, Bishop. Three adults found resting on sandy roads during a heavy rain July 17, 1956, by Dr. Charles Stine and Mr. James Fowler.

Frederick County (western Maryland in the Appalachian Highlands).

1. MNHUI 2797, High Knob Rd. between Frederick and the Catoctin Mts. An adult found on highway 2.5 miles N.W. Frederick, Sept. 13, 1948, during a rain by Mr. W. Leslie Burger and Mr. J. T. Burger.

2. RSS 101, Frederick. A single adult dug from a garden six inches below the surface Apr. 21, 1956, by Mr. Austin Rhoades. The last two records listed above are significant in that they are the first for Maryland west of the fall line and represent a range extension in Maryland for this species of 48 miles N.N.W. from the Glen Burnie, Anne Arundel County. station. However, that the species is thoroughly distributed throughout the state cannot be determined until the areas now appearing as large hiatuses are more intensely investigated.

We extend our thanks to Dr. Hobart Smith, Dr. William Bayliff, Mr. Romeo Mansueti, Mr. John Cooper, Mr. W. Leslie Burger and Mr. David Hardy for generously supplying information regarding some of these records.—*Charles J. Stine, Robert S. Simmons and James A. Fowler. Natural History Society of Maryland, Dept. of Herpetology, Baltimore, Maryland.*

Notes on Natural History of a South African Agamid Lizard

By R. B. COWLES

Agama atricollis Smith (=*cyanogaster* Rüppell) is a robust lizard, the males reaching more than 300 mm. in length. In many respects its coloration, habitus, habits and habitat resemble those of the larger iguanid lizards of the genus *Sceloporus* of North America.

According to Fitzsimons the Afrikaner's colloquial name for the species is Blouhop Klipkoggelmander. The British residents of Natal have modified the term to Blueskops lizard, both terms having reference to the conspicuous bright blue heads of the males. Depending on locality the Zulu name is either n'tulo or iqimilili.

To all of the natives of South Africa this harmless lizard is an object of great fear even though many of them know it to be non-poisonous. It is probable that the fear is based on superstition, but since related forms are objects of antipathy to the culturally, geographically and religiously remote Mohammedans of North Africa, as well as to the tribes of South Africa, there must be some anatomical or behavioral trait that despite the gorgeous coloration of the animal is conducive to some common revulsion in mankind.

Among the Zulus this common and most conspicuous species may be the one implicated in one of their legends as having been given the message of death from God, whereas a chameleon was appointed to carry the message of eternal life. The darting speed and active habits of the *Agama* enabled it to win the race and deliver its fateful message, whereas the much slower, hesitating or vacillating movements of the chameleon brought it too late and thus by chance man is only mortal. Because of this legend both species are detested and the standard treatment of the chameleon is to annoy it until it opens its mouth when a pinch of snuff (a mixture of dried and finely ground tobacco and the leaves of an Aloe, known to the Zulus as "umhlaba") is tossed between the gaping jaws causing death in a few minutes.

The Mohammedans give as their reason for hating the lizard, the animal's proneness to head-bobbing which they believe is an intolerable mimicking of their bowing to Allah.

Some of the informed Zulus denied that this Agamid is the species entrusted with God's message but they insist that it is so disgusting that they fear it. Others claim that this is the lizard referred to in the legend but they state that their fears result from other causes. It seems to be universally true that the sight of this lizard is repugnant, especially when it is "bobbing." The superstition may result from these almost obscenely suggestive movements which in fact may consciously or unconsciously provide a basis for the belief that the reptile was in some way involved in the process of life and death.

Irrespective of the manner in which the head-bobbing habit may be involved in superstition, these lizards are as notable for this behavior as are many of our American species, and the action is evoked by apparently the same strong stimuli: courtship of the females, aggressive displays

by males, or by the proximity of potential danger. It seems possible that the underlying factor that causes these "push-ups" or bobbings may, of course, center around territoriality and mating. That there may be a presumable common utility derived from the action would seem to be supported by its occurrence in so many species of several families of lizards of disparate geographic distribution and different phylogeny.

The bobbing habit may have originated in some very remote common ancestor of lizard families and have persisted despite increasingly divergent morphological characteristics. That this might be the explanation seems highly improbable in view of the well known fact that any movement reduces or destroys the value of camouflage, *i.e.* procrypsis, and attracts the attention of predators and thus would be expected to penalize, or select against, the retention of such an inimical trait unless other positive values have contributed to the retention of this habit.

Equally speculative, but more in keeping with evolutionary theory, would be the supposition that head-bobbing possesses some other inherent, but presently not understood direct survival value, possibly an enhanced depth perception resulting from the compensating movements of the eye or the movement of the image across the retina, as discussed by Walls, (1942, Bull. Cranbrook Inst. Sci. 19.). Head movements of this type are not only commonly found in lizards, supposedly with essentially monocular vision, but also in birds and in both especially when excited by various stimuli. Investigations as to the effects of these movements on vision, especially monocular vision, might yield valuable results.

Of interest but possibly of negligible significance, was one observation made at Umzumbe, South Africa, where for several minutes the synchronized but intermittent head-bobbing of a pair of land kingfishers *Halcyon albiventris* (Zulu: *unongozolo*) apparently evoked the same response in a pair of these lizards some 20 feet distant.

The Agamids, especially the less colorful females, are excellently camouflaged while on their habitual backgrounds of tree trunks or larger limbs of trees where either the patterns formed by the scaly bark or scattered patches of lichens render the lizards undetectable so long as they are motionless. The males with their vivid blue heads are more readily detectable than the usually more sober-hued females, which raises the question of the effectiveness of concealing coloration. In general, the females lack the vivid blue heads, but in one instance an individual with electric blue coloring indistinguishable from that of a highly colored male, on October 25 (early summer), 1953 contained 10 well developed eggs.

The thermal characteristics of these lizards closely resemble those most characteristic of our diurnal nearctic Iguanids.

Several experiments were conducted with captive animals while they were tethered by threads to stakes driven into bare ground. In tests of the heat-absorbing capacity it was found that when six adult lizards were placed in the sunshine, with a starting body temperature of 23°C and with a cool breeze of 23° blowing across them, within ten minutes, in spite of a few scattered thin clouds drifting past, their body temperature rose to an average of 33°C. This is a 10°C rise in 10 minutes under very moderate conditions and is indicative of the nearly identical heat-absorbing efficiency of the darker males and lighter-colored females. At

least under these conditions there was no detectable difference in heating rate between the males and females. Slight irregularities in heating rate were noted but seemed to be related to size rather than coloration or albedos.

These same four males and two females were studied on a morning when the sun intensity was moderate and they yielded the following information. Start of the experiment at 8:30 a.m. Body temperature 22°C, air temperature ¼ inch above ground, 22°C, surface of the ground 21°C. 9:00 a.m. Bodies 34, 35, 34.5, 36.2, 33.6, 35°C. These body temperatures did not appear to be influenced by the angle of the body with respect to the sun. Air at body level at 9:00 a.m. had dropped slightly to 21.6°C, and this balance between heat absorption and heat loss gave an average net gain of 13.1°C. On continuing these tests for presumably different absorption rates resulting from different spontaneously adopted exposure angles, at 9:10 all but one were tail to the sun, whereas two minutes later all were broadside to the sun and a minute later they were again arranged tail to the sun. Five minutes later they were arranged in a circle with all exposures represented. These variations in orientation with respect to the sun continued until 9:25 at which time tests were made to determine whether or not the last orientation was a response to body temperature and its control, or whether it was related to fear of some object, proximity of some escape opportunity, or any other factor. So far as could be ascertained it was either fortuitous or was correlated with body temperature, but the latter cannot be established with the available means of observation since temperature taking disturbed all the remaining animals and there was also sufficient time lapse between animals to permit a moderate temperature change while moving the thermometer from animal to animal. It would be necessary to have simultaneous and virtually continuous readings since the animals can modify their temperatures slightly by respiration. While making the above observations representing seven positions of orientation, the animals might run to the end of their tethers and then turn, thus either fortuitously getting into these positions or selecting them in response to "comfort" relative to amounts of sunshine on the body.

A later additional re-check on orientation gave no conclusive evidence that this device is employed as protection against overheating. Three checks were made at five minute intervals when the breathing was becoming more rapid, but before panting was initiated. All were broadside to the sun and in order to check on some unknown stimulus being responsible for their positioning, the observer moved into close proximity so as to introduce the fear reaction and thus alter this orientation. None responded and they remained broadside.

By 9:30 a.m. the air at their level was 22-23°C and body temperatures had reached 38.4, 37.2, 36.2, 38.2, 38.8, 38.5°C, an average of 14.8°C above the air temperatures and representing the increased heat uptake resulting from the slightly higher elevation of the sun with less atmospheric absorption and a more favorable angle of incoming light.

These normally arboreal lizards appear to have almost no blanching capacity as compared to our California desert species. As their temperatures increased their body color remained almost the same hue as when cold. This may be related to the almost invariable availability of cool

shade and the dictates of procrypsis while engaged in foraging, courtship or concealment from an enemy. At no time would they be obliged to remain in sunlight long enough to become overheated and this may be another reason for their apparent inability to utilize varying albedos.

By 10 a.m. and under more intense sunlight two of the animals had their mouths open and body temperatures were 39.6, 37.8°C. The air at their level was 23-24°C, and at 10:15 all of the animals were panting.

At 10:20 a.m. they were still panting and three were warmed to 41, 38.5, 41.6°C. At this time a cool breeze started blowing producing 20-21°C. at their level, but those that continued panting, now closed their mouths at intervals. All of the lizards were oriented tail to the wind and broadside to the sun. Because all of the nonpanting individuals were also exposed to identical environmental influences it is assumed that they represent either individual differences in heat tolerance or of cooling capacity.

The breeze died down and by 10:45 a.m. the following was observed: 40.4°C. nonpanting, 39.4°C. occasionally panting, 39.6°C., and 39.8°C. nonpanting. Within this narrow range, individual or momentary variations for each individual suggest that this is the critical thermal level at which discomfort sets in and additional energy must be expended for cooling. The individual of 39.4°C. started panting but its temperature nevertheless increased to 40.2°C., whereas an individual at 39.6°C. started panting and in two minutes was 37.8°C. Another started panting at 40.2°C. and when it stopped panting its body temperature was 39.2°C. Apparently respiratory cooling by the cooler air, but not necessarily evaporative cooling, under these specific conditions is moderately effective. By 11:10 all but one of the lizards were panting and these were at 40°C., but the nonpanting individual remained at 38.4°C.

The solar radiation was by now reaching a point where the animals were finding it difficult to dissipate heat as rapidly as it was being absorbed. The nonpanting individual at 38.4° differed only in having more widely distributed blue coloration than the others and at intervals kept lifting its body from the ground whereas the others did not.

One notable feature was the fact that as they reached or slightly exceeded 39°C. all defecated and oozed cloacal moisture, and the cloacal lips became flaccid, making it easier to insert the thermometer but requiring deeper penetration in order to obtain temperatures that would be minimally influenced by cloacal evaporation.

At 11:30 a.m. the orientation was still meaningless insofar as any explicable factor was concerned. All were more or less broadside to the sun although it was nearing the zenith. Their heads were all more notably elevated, and they were not so nearly flat to the ground as earlier in the day. The aforementioned nonpanter, seemingly without design, was almost continuously pointed into the sun and kept the body elevated. This may explain its slightly lower temperature, but in view of the position of the others it does not indicate that spontaneous orientation is an adaptive device in this species.

All of the lizards were by now more flaccid, seemingly suffering a reduced muscle tonus, and were beginning to show the effects of either the intensity or the duration of exposure to excessive, non-normal temperatures.

It is notable that unlike many of our desert species none of these arboreal lizards made the slightest effort to find underground shelter or to dig, yet they were all suffering from the heat and were shaking their heads from side to side in obvious distress. As judged by the behavior of our desert lizards these animals were probably just reaching their critical maxima; somewhat longer exposure or very slightly higher temperatures would have caused death.

Two nonpanting individuals at 38.5°C., 38.6°C. and two others panting at 40°C. suggest that these temperatures bracket thermal conditions that initiate this heat-dissipating behavior.

At intervals the cool inspired air was as much as 17°C. below the maximum body temperature. Therefore the thermal gradient together with the open mouth and occurrence of what must be some evaporative cooling during inspirations, as well as evaporation from cloacal exudate and possibly some heat conduction to the ground contributed to staving off the final overheating even as late as 11:30 a.m. Although the experiments were only intended to determine lethal temperature rather than the contributing environmental conditions, it is nonetheless an inexcusable oversight that soil surface temperatures were not recorded throughout. However, it can be said that with moist soil and temperature of the air at ¼ inches above the surface reaching a maximum of only 24°C., a well-informed guess would place surface temperature at less than 28°C.

Even when the breeze weakened, the air temperature at their level rose to only 21.5 to 24°C. Under these conditions noncaptive animals would normally retreat into a tree where the air would be cooler; in fact at only 1.5 meters above ground, temperatures fluctuated between 20 and 22°C. whereas on the ground at the lizard's level they reached a maximum of 24°C.

The highest body temperatures sustained by these lizards was 42°C., a temperature maintained not over 20 minutes. No lizard reached the full critical maximum temperature as defined by Cowles and Bogert, (1944, Bull. Am. Mus. Nat. Hist. Vol. 38, Art. 5.), nor were any of them visibly injured although discomfort was apparently intense.

So far as these observations indicate there seems to be no notable difference between these climatically subtropical, and geographically remote representatives of Agamids and our southwestern Iguanids.

These experiments revealed no clues as to whether or not color is of value as a physiological, heat-absorbing and temperature-mediating factor in these lizards, and there was no visually detectable blanching or darkening of color under the changing conditions reported here.

Because of the notably rapid heat uptake in these cold-blooded animals and the absence of perceptible color change within the observed range of body temperatures extending from torpidity to near the critical maximum or lethal, their predominantly dark coloration might be a theoretical disadvantage during the summer months whereas under minimal or marginal climatic conditions the rapid rate of heat uptake might be advantageous. Certainly additional studies are needed to settle the present differences of opinion regarding the physiological determination of coloration versus the factor of procrypsis and predator pressure. Subjective conclusions based on observation of these as well as many other species

of diurnal reptiles incline this observer to the conclusion that procrypsis dominates or overrides putative physiological thermal benefits.

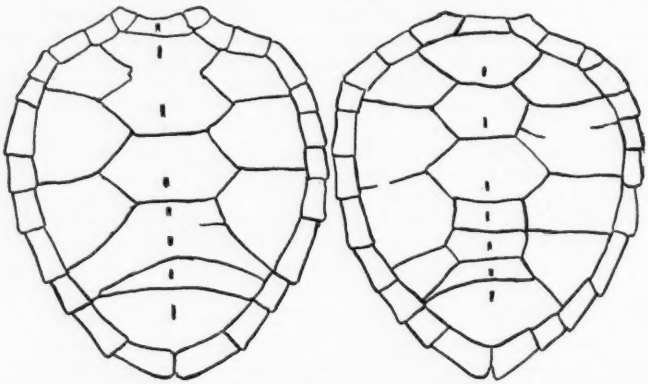
The relatively great hiatus between air temperatures and body temperatures indicates the appropriateness of designating these animals as heliothermic ectotherms.

These observations were made while engaged in other biological work under a research grant from the Wenner Gren Fund for Anthropological Research.

UNIVERSITY OF CALIFORNIA, LOS ANGELES 24, CALIF.

ABERRANT LAMINATION IN TWO HAWKSBILL TURTLES.—Two hatchling hawksbills (*Eretmochelys imbricata* Linnaeus), taken near Banes, Oriente, Cuba, were given me by a native. They had been preserved in formalin and the exact location of hatching was not obtainable. They are of interest because of some unusual scute abnormalities.

(S.D.S.N.H. Nos. S19170-19171)



Note in left fig. that the first and second neurals are fused, each being represented by a boss or knob indicated in the sketch. Knobs 4 and 5 represent the fusion of two neurals and a pair of costals. The succeeding strap-like scute is an abnormailty that cannot well be explained by a fusion with a costal because the 4 costals are accounted for. The marginals and plastron are normal. I have never seen or heard of a single scute passing from marginal to marginal.

In right fig. instead of 5 neurals there are 7, one of which extends to the marginals. The second right costal is almost divided. The left marginals are 11 instead of 12. The plastron was normal.—*Chapman Grant, Route 1, Box 80, Escondido, California.*

Larvae of Some Appalachian Plethodontid Salamanders

By Theodore H. Eaton, Jr.

As it is often difficult to distinguish the species of Plethodontid larvae, and published descriptions are scanty, the writer has tried to work out the recognition characters for several Appalachian species, accompanied by reasonably full descriptions of color and form. This research was aided by a Grant-in-Aid from the National Science Foundation, administered through the Highlands Biological Station, Highlands, North Carolina. Like other investigators at the Station, I am much indebted, for help and interest, to the Executive Director, Dr. Thelma Howell.

1. General Features of Plethodontid Larvae

In the Appalachian region the more terrestrial genera, *Plethodon* and *Aneides*, have no larval stage and possess gills only as embryos, before hatching. A second group, including *Desmognathus monticola, ochrophaeus, perlapsus*, and presumably *wrighti*, hatch with gills but quickly lose them and are not ordinarily collected in the gilled state. The forms with which this paper is concerned are those having a "normal" larva with functional gills: *Desmognathus fuscus* and *quadramaculatus, Leurognathus marmorata, Eurycea bislineata, Pseudotriton ruber*, and *Gyrinophilus danielsi*. (*Hemidactylium* and *Stereochilus* were not included in the present study, nor were the neotenic or permanent larval types, *Typhlomolge, Haideotriton*, and certain species of *Eurycea*, which are outside the Appalachian region.)

It is generally agreed that the Plethodontidae are derived from the Salamandridae, from which they differ, as adults, in the absence of lungs and an ypsiloid cartilage, and the presence of nasolabial grooves. Larvae of the Salamandridae have four pairs of gill slits, and the gills (three) consist of extended rami from which two series of filaments arise on the outer and lower side. Gills like those in the Salamandridae are characteristic of Plethodontids with the exception of *Desmognathus* and *Leurognathus*, in which the rami are much reduced (but not, as sometimes stated, absent). On the other hand, these two genera are the only Plethodontids with four gill slits, undoubtedly a primitive feature, reduced to three in the others. Most of the larvae of Salamandridae have a dorsal keel or fin along the entire trunk and tail. The occurrence of such a fin in only one Plethodontid larva, *Hemidactylium*, is supposed (Dunn, 1926, Salamanders of the Family Plethodontidae) to be secondary, and correlated with life in still water; in all others, which live in streams, the fin is restricted to the tail.

The sensory pore system in larvae shows little variation in arrangement, but the pores are conspicuous in some genera, notably *Gyrinophilus* and *Pseudotriton*, whereas in *Desmognathus, Leurognathus* and *Eurycea* they are closely associated with the development of the pattern of pigmentation in the skin, although the pores themselves may be inconspicuous. Sensory pores on the body lie in three rows on each side: (1) *Dorsolateral*, on that part of the trunk which contains the epaxial

muscles. Pores of this row are not on every segment, but may skip one or even two at a time. They continue along the tail, either part way or all the way to the end at the level of the upper margin of the tail muscles; in this case the pores are on practically every segment in the tail. (2) *Lateral*, on a line corresponding to the horizontal septum between epaxial and hypaxial muscles, usually the the upper end of the costal folds of the trunk. These pores are approximately at the level of the most posterior head-pores, above the gills, and continue back on all or nearly all segments, passing above the hind legs and either part way or all the way to the end of the tail, at its midlevel. There may be, as in *Gyrinophilus*, two pores to a segment in some places in this row. (3) *Ventrolateral*, at the level of the bases of the legs. This row usually does not extend past the hind legs, but may do so for three or four segments. It lies at or just above the lower edge of the pigmented zone of the trunk.

In *Desmognathus*, *Leurognathus* and *Eurycea* the development of pigment in the skin is usually delayed in the area immediately surrounding each pore, so that a series of pale spots can be seen with the naked eye in the position of each pore-row. It will be convenient to refer to these as pore-spot rows 1, 2, and 3 respectively. Row 1 is most conspicuous, and the spots so formed contribute to the adult pattern whether the pores persist or not. (These pore-spots are the "larval areas" referred to by Dunn, 1926, *op. cit.*, following McAtee, 1906, Proc. U. S. Nat. Mus., 30:74-83). Other pale spots or streaks may be present, either in a regular order (*Stereochilus*, figured by Bishop, 1943, Handbook Salamanders: 348) or in a scattered or reticulated pattern.

On the head, also, there is only minor variation in the distribution of pores. A short row extends forward above the base of the gills; mediad to these is a small cluster over the otic region of the skull. These may be called the *supratemporal* row and cluster, respectively. A *postorbital* row runs transversely behind each eye; dorsally it meets the *supraorbital* row either in a right angle or in a curve. The supraorbital goes forward along the inner side of the eye, and may or may not be separate anteriorly from the *nasal* row, which runs to the upper lip along the medial side of the nasal organ. The *infraorbital* row, which may become a field of pores anteriorly, follows the upper jaw and extends up in front of the eye, as well as along the jaw below the nostril. The *mandibular* row follows the edge of the low jaw; the *hyoid*, originating further back on the cheek, curves forward toward the middle of the gular region. Of these head pores, the ones most likely to be associated with pale spots are the mandibular, infraorbital, and supratemporal, but if the skin pigmentation is uniform, then the pores themselves may show as conspicuous white dots.

The eyes of larvae are without lids, but at metamorphosis they become elevated and the lids appear. The margin of the lower jaw on each side of the chin is inflated and set off by a deep groove as a labial fold. This disappears at metamorphosis.

2. Larvae of *Desmognathus and Leurognathus*

Any Plethodontid larva with a distinct dorsolateral row (1) of pore-spots, and the ramus of each gill not more than half the length of the gill, belongs to this group. Outside the Appalachians such a larva is almost certain to be *D. fuscus* (or one of its races); *D. f. fuscus*, of

course, is also common in the mountains. Young larvae of *Eurycea bislineata* may look a great deal like a *Desmognathus* at the same age, but the gills have a long ramus, from which the filiments branch in series.

Desmognathus f. fuscus. According to Bishop (1943, *op. cit.*), who gives a figure of a newly hatched larva, the length at hatching is about 16 mm., and at transformation, in 7 to 9 months, about 44 mm. He describes the gills as "glistening white," but in my experience this is rather a character of *D. quadramaculatus* and *Leurognathus*, those of *fuscus* having some dark pigment. Measurements of my largest and smallest larvae are tabulated with those of other species, in Table 1.

Description of a 38-mm. larva (Mt. Mitchell, N. C., 6000 ft., July 22, 1956): Venter white except for gray mottling at tip of chin and labial folds. Ventral tail fin white with slight speckling distally. Legs and feet white beneath, but dark color reaches part way on under side of fore arm and lower leg. Upper parts mostly brown with black markings. There are two obvious kinds of pigmentation: a superficial, very fine dotting, which by itself gives the brown effect, and deeper, blacker melanophores, either scattered or gathered into patches. First row of pore spots paired, approximately every other segment beginning over fore legs and going to tail, and confluent with median brown stripe, so that they look like cogs on its edges. In each spot the pore shows as a white dot. These spots do not show along tail but the pores continue along upper edge of its muscular zone. There is blackish pigment between successive spots on the trunk, and lateral to them, also irregular black spots along midline. On side of trunk second pore-spot row on each segment, pale brown and smaller than spots of row 1; only about 5 pores and spots of row 2 on tail. Dark pigmentation above and below row 2 tends to form lateral streaks becoming more open reticulation ventrad and on sides of tail. Lowest pore row (3) on trunk has white spots, barely enclosed by pigment. Upper surfaces of legs and feet brown with irregular blackish spots. Dorsal tail fin white with scattered black spots. Head: three dark patches on cheek between eye and gills. Dark spot at occiput; elsewhere scattered irregular mottlings on brown background. Gill rami (bases) brown; filaments flattened, with few pigment cells. Sides of throat faintly pigmented to a little below level of corner of mouth.

Body width expressed as percentage of length from axilla to groin in a series of six larvae of different ages averages 29.8%; *fuscus* is definitely more slender than *quadramaculatus*, with 39.2%, but not quite as slender as *Eurycea bislineata wilderae*, 26.7% All pore-spot rows on the body show in the larvae of *fuscus*, but the third row of spots in the smaller ones may not be enclosed in pigment, thus giving a scalloped edge to the pigment zone. The gills are partly pigmented in all. There are 14 costal grooves.

Desmognathus quadramaculatus. Larvae of this species are common in rocky streams of the southern Appalachians. Bishop (1943, *op. cit.*) gives the range of size as 20-89 mm. My smallest is 18.2 mm. Pope (1924, Amer. Mus. Nov., 153:1-15) figures a larva of 20 mm., but the pattern present in small larvae is only partly shown in the illustration. *D. quadramaculatus* is considered by Dunn (1926, *op cit.*) to be directly ancestral to *Leurognathus*, and I agree. Any larva with short,

Table 1. Measurements of larval salamanders.*

	Total length	Snout to vent	Head length	Head width	Axilla to groin	Abdominal width
	20	12	3.5	2.8	6.5	1.7
D. f. fuscus	38	21	6	4.2	11.5	3.4
	18.2	10.6	3.5	2.4	6.7	2.5
D. quadramac.	73	38	9.5	7.8	20.5	7.8
	22	13	4	3	7	2
L. m. interm.	51	27	7.5	5.8	15	6.1
	16.6	10	3.2	2.6	5	1.8
L. m. marm.	60	30	8	6.8	15	7
	23	13	4	2.8	6.9	2
E. b. wilderae	43.5	21.5	5	3.8	12	2.9
	34	18	5.2	3.4	9	3
G. danielsi	90	54	12	10	32	10.2
P. r. schencki	55.5	31	8.2	5.1	18	5.1

*The upper figures for each species are my smallest specimen, and the lower are the largest (larvae), except in the case of *P. r. schencki*, where my 3 specimens are nearly the same size. Snout-vent length is to the anterior end of vent; head length is the (longitudinal) distance from tip of snout to most posterior part of gular fold. All figures are in millimeters.

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white gills will be one or the other; the whiteness is due not only to lack of dark pigment but to silvery white guanophore cells.

Description of a 68.5-mm. larva (Highlands, N. C., 3700 ft., June 13, 1956): Venter, throat, and anterior quarter of tail beneath white, with uneven edges; also underside of limbs, but not feet. Margins irregularly marked with brown, consisting of either superficial, very fine dotting, or deep, distinct, dark cells, or both. Edge of throat and chin irregularly pigmented. Ventral side of feet, toes and inner angle of elbow pigmented. Pale spots around pores on trunk and tail have the very fine superficial dotting but not the deep, dark melanophores; the latter are responsible for all dark markings. Where both kinds of pigment are absent there are minute white spots: these are scattered, few, on head, and a small cluster of 3 or 4 around each pore of row 1, and again on sides of tail, but are not conspicuous. Pore spots of row 1 are pale brown, about 2 mm. in diameter, the pore near lateral edge of each; the spots merge into median straw-colored or pale russet band on base of tail, to about one third of way back from hind legs. (Note: A pattern similar to this may be seen in some specimens of *monticola, ochrophaeus carolinensis*, and *fuscus*, especially the southern races, but of these only *fuscus* will have gills, and they will not be conspicuously white.) Pore

row 2 extends along trunk from gills in straight line except for a dip as it reaches tail, then continues along side of tail at midlevel. The pores are in small, inconspicuous light areas. Pore row 3 is at level of bases of legs; 2 pores on some segments, 1 on most. The pale spots surrounding these pores do not show up in the general mottling of lower part of trunk and tail. Spots of row 1 separated and margined laterally by blackish blotches. On head, 4 irregular black spots, 1 at occiput, 1 in midline just back of eyes, and a pair in parietal position. Rim of upper jaw slightly swollen.

General appearance robust, slightly stouter than *Leurognathus* at corresponding stages, and much stouter than *D. fuscus* or *Eurycea*. (See comparative figures given under *fuscus*.) So far as my series goes, the differences given by Dunn (1926, *op. cit.*) between *D. quadramaculatus* and *L. marmorata* (eyes larger, more dorsal in the latter, and throat darker) do not hold in comparing a number of specimens of each, nor do certain differences noted by Bailey (1937, Occ. Pap. Mus. Zool. Univ. Mich., 364-:1-10), except that *quadramaculatus* is lighter and has more distinct markings. Differences which do seem consistent are listed in the discussion of *L. marmorata* below.

In my smallest larva (18.2 mm.) the eyes face dorso-laterally, but in larger onces they turn diagonally forward as well as up. This is also the case in *Leurognathus*. Careful measurements fail to show a difference in size or position of the eyes between the two. With increase of size there is a darkening of color and greater distinctness of pattern in *quadramaculatus*. The beginning of metamorphosis is shown by reduction in gills, lengthening of snout before eyes, loss of labial folds, and reduction of ventral (later of dorsal) tail fin. Darkening of the ventral surface of the body does not occur until later in adult life. The costal groove count is 14.

Leurognathus marmorata. The adult *Leurognathus* differs from *Desmognathus* in the lateral displacement of the internal nares, lack of vomerine teeth, and absence of a fontanelle in the premaxillary. The skull is slightly flatter. In view of the detailed agreement with *Desmognathus* in other respects, and particularly with *D. quadramaculatus*, it is doubtful that a generic distinction is necessary. In life-history and larval characters these species are much closer than are some kinds of *Desmognathus* to one another. *L. marmorata* has two races, of rather limited distribution, both inside the range of *quadramaculatus*. The following table shows the differences between the larvae of these three forms, so far as I have been able to make them out from a series of each.

Detailed description of a *Leurognathus* larva does not seem necessary in view of the foregoing. Larvae of *L. m. marmorata* are described by Pope, who gives a good figure (1924, *op. cit*), as having a length of 17 mm. a few days after hatching, while according to Bishop (1943, *op. cit*), they may reach 66 mm. before transforming. My smallest and largest are 16.6 and 60 mm., respectively, and my *L. m. intermedia* series falls between those limits. Both adults and larvae of *marmorata* look darker than those of *intermedia*. Three small (16.6-18 mm.) larvae of *marmorata* have a straight, even edge to the pigmentation at sides of head, trunk, and anterior half of tail. The pale spots are not as contrasting at any stage in either race as they usually are in *quadramaculatus*. The gill rami,

which are short, stubby or triangular, are pigmented, but the filaments are shiny white. The abdominal width of 10 *marmorata* larvae expressed as percentage of length from axilla to groin averages 37.5%, which is only slightly less than that of *quadramaculatus*. *Leurognathus* larvae have 14 costal grooves.

Table 2. Comparisons of desmognathine larvae.

D. quadramaculatus	*L. m. intermedia*	*L. m. marmorata*
1st pore-spots opposite or alternate, large. Dark zone in middle is not wider than diameter of spots. Spots usually merge with pale band on base of tail. Mottling in middle (dorsum) of trunk and head.	1st pore-spots paired, rather widely separate, not merging with median band or each other. Space in middle dark, and twice as wide as diameter of spots.	1st pore-spots barely visible in dark pigmentation of dorsum. but more conspicuous in very young, and at metamorphosis.
Sides and tail somewhat coarsely and unevenly mottled with light brown.	Spots on sides small, forming 2 or 3 rather even rows, more irregular on tail.	Sides seem uniform to naked eye. Tail finely mottled with white, especially on fins.
Eyes contrasting dark in pale or mottled color of head.	Eyes dark but skin of head nearly uniform brown, or weakly mottled.	Eyes no darker and may be lighter than uniformly blackish-brown head.
Pores on head usually show clearly with lens, but along jaws and in younger larvae they are in pale spots, hence less obvious.	Pores on head often enclosed in small pale spots, especially on jaws.	On account of dark pigment of head the pores show clearly with lens as whitish dots, not enclosed in pale spots.

3. Larvae of *Eurycea*

Eurycea bislineata wilderae is the only form of this genus found commonly in the southern Appalachian mountains. At lower levels south and eastward it intergrades with *E. b. cirrigera*, and northward with *E. b. bislineata*. *E. l. longicauda* occurs westward, and *E. l. guttolineata* to the east, but I have not met these in the mountains proper. Between the races of *E. bislineata* I do not see significant larval differences; the races are grounded on adult characters, which are the end-results of a rather extensive series of changes of color and pattern in the larvae. A young larva of *E. b. wilderae* has little resemblance to one which is near transformation, although it is quite like a young *Desmognathus fuscus*. It can be distinguished as *Eurycea*, however, by the gills, which contain flat-

tened filaments branching in two series from long, slender rami. The ground color is rather yellowish-bronze than brown or gray. Head and body are both more slender than in *Desmognathus;* abdominal width in 7 larvae of different sizes averaged 26.7% of length from axilla to groin. Costal grooves are normally 14.

In larvae of *wilderae* less than 30 mm. long the pattern is very similar to that described previously for *D. f. fuscus,* even to details of spotting. But the very fine superficial dotting in the skin, which is responsible for the brown of *fuscus,* is here much thinner and goes no farther ventrad than the second pore-row. The three pore-spot rows are easily visible on the trunk; the lowest may be only partly enclosed in scattered pigment dots. Row 1 continues, well marked, out on the tail along upper edge of musculature. Only about 6 pores with spots, of the second row are found on the tail; beyond them the tail is lightly reticulated. There are dark irregular blotches between successive spots of rows 1 and 2, and between these rows; more ventrally is a thinner scattering of melanophores. The pale dorsal stripe contains random dark spottings.

In older larvae (35-40 mm.) the dark blotches between spots in rows 1 and 2 have faded but are still faintly visible. Between these rows, however, the pigment begins to form a nearly continuous dark longitudinal line. In the dorsal stripe pigmentation is lighter and more uniform than before. The second row of pore-spots is still evident, but below them the sides are more lightly and uniformly pigmented. The tail is still reticulated at the edges and toward the end.

In larvae beginning to transform (over 40 mm.) the dorsal tailfin disappears, leaving a narrow dark line. The dorsolateral lines are strong, going forward to the eyes, while the background color is yellower than before. The second row of spots is faintly present. The dorsal stripe contains black spots and streaks at some of the places where spots of row 1 were originally separated by pigment. Thus the adult pattern is nearly established while the gills are disappearing.

Bishop (1943, *op. cit.*), records larvae from 17 to 55 mm. My largest with gills still present is 43.5 mm.

4. Larvae of *Gyrinophilus* and *Pseudotriton*

These two genera, considered by Dunn (1926, *op. cit*), to be the most primitive of the Plenthodontidae, differ in the larval stage from those already discussed in lacking any sort of regular pattern of markings, and in their remarkably smooth, eel-like form; perhaps correlated with this is the larger number of costal grooves, 16 in *Pseudotriton ruber schencki,* 18 in *Gyrinophilus danielsi.* The gills are prominent, with long rami and many flattened filaments in two series. The legs are relatively short and the eyes small. Presumably this, as well as the lack of color pattern, is correlated with the secretive habits of these larvae, for they do not walk about on the bottoms of pools, but creep through crevices under stones, in mud, or in drifted leaf accumulations.

Gyrinophilus. The southern mountain species of this genus is *danielsi.* According to the study by Reese (1950, Nat. Hist. Misc., 63:1-7), *G. d. danielsi* occurs in the Great Smokies and northeast along the Tennessee-North Carolina line about as far as Grandfather Mountain. *G. d. polystictus* is the race found in the higher parts of the Black Mountains (including Mt. Mitchell), and which was described and illustrated as

G. d. danielsi by Bishop (1943, *op. cit.*). *G. d. dunni* occurs south and southwest of these, at somewhat lower levels, and into Georgia and South Carolina. I cannot distinguish between the larvae of *polystictus* and *dunni;* the races seem to be recognizable only as adults.

Grobman (1943, Anat. Rec., 87:211-214) noticed an interesting point in the anatomy of *Gyrinophilus,* which differs from *Pseudotriton* in the adult stage in having two premaxillaries instead of a single one. In *G. porphyriticus* he found that the premaxillae become separated by a suture in the adult after being fused in the larvae. This is apparently a unique case, for dermal bones frequently fuse, but have not been known to develop a suture later.

Bishop (1943, *op. cit.*) gives the length of larvae of *danielsi* (i.e., *polystictus*) at hatching as about 1 inch (25 mm.); my specimens from Mt. Mitchell and Clingman's Peak (not Clingman's Dome, which is in the Smokies) range from 28 to 69 mm., but the last is not close to transformation. Of *G. d. dunni* I have larvae from 34 to 98 mm. Since no reliable distinction is apparent to me between these, I shall use one specimen of *dunni,* 75.5 mm., as an example (Cold Mt. Gap, on the Jackson-Transylvania County line, N. C., 4000 ft., July 11, 1953):

Beneath white, including legs, feet, tail and ventral tail-fin, but throat and chin margined with brown, a point of brown coming back to midline halfway to gular fold. This and the color on sides is faint where it meets the white, but on trunk the line is nevertheless straight and distinct, at midleg level. The lowest sensory pores (row 3) are about 1.5 mm. above this line. Color above and on sides quite uniform brown with slight purplish tint, a few dark spots showing very faintly on sides. There is a faint uneven dark line in mid-dorsal groove. Toes white, also line across joint of each foot on upper side. Tip of tail white above and below the middle brown streak. Upper lip and each side of snout swollen in the pore area, so that in profile the head shows a depression just at the front of the eyes. There are no markings associated with the pores. Row 1 on trunk is about 1 mm. above a distinct horizontal groove marking the septum between epaxial and hypaxial muscles; the pores of this row are on (roughly) alternate segments, and continue so to about one half the length of the tail, on its upper part. Row 2 is approximately in the groove, and is segmental, with occasionally 2 pores to a segment; it continues along tail, rising above midlevel in the anterior two thirds, then dropping to midlevel to the end. Row 3 is 2 mm. below row 2, begins on second segment behind fore limb, has 2 pores on most segments, and terminates in front of hind leg. The head pores show very clearly against the uniform dark ground-color, and are essentially as described in the introductory section; the supratemporal cluster consists of 8 pores in an ellipse, and the nasal row overlaps the supraorbital.

As compared to *Desmognathus* or *Leurognathus* larvae of equal size, the eye in *G. danielsi* has a diameter of ¼ to ⅓. A small (28 mm.) larva, compared to one of *Eurycea b. wilderae* of the same size, has the eye diameter less than ½. A 34-mm. larva *G. d. dunni,* from Wayah Bald, N. C.) has white spots enclosing some of the pores, and an irregular row of white mottlings along the mid-dorsum. Preserved larvae have the gill rami pigmented, but the filaments are white. There are normally 18 costal grooves, occasionally 17.

Pseudotriton. The southern Appalachian races are *P. ruber nitidus* northeast of the French Broad valley in North Carolina, and *P. r. schencki* south and west of this. The ranges of both are surrounded, at lower elevations, by that of *P. r. ruber.* My material consist of three half-grown larvae of *schencki,* but as the adults of these races are not distinguished by any very striking features, the following notes will presumably apply to larvae of the others. Apparently hatching is at about 25 mm., and transformation at 60 to 70 mm. (Bishop, 1943, *op. cit.*).

Compared with the larvae of *Gyrinophilus, P. r. schencki* has no lateral groove at the edge of epaxial muscles, and mid-dorsally there is a slight ridge rather than a groove. Pores on trunk and tail are virtually the same as in *Gyrinophilus,* except that a segment rarely contains more than one pore of a given row. The supratemporal pore cluster contains 8 in a circle, rather than an ellipse; the supraorbital row seems to split, going forward as a double row to the snout, the inner one actually being the nasal. The snout is not swollen as in *Gyrinophilus,* so that the head profile is nearly even. On the sides scattered spotting occurs below the level of general brown pigment, but the latter extends below pore row 3. Upper parts with dark irregular mottlings, but no pattern associated with pores. Ground color reddish (not purplish) brown. Ventral tail fin lighter than upper parts, but has faint speckling and is not white. Toes white only at tips on upper side. Throat white but with some speckling at sides below angle of mouth. Gill filaments white, in contrast to brown rami (as in *Gyrinophilus.*). Compared to *Desmognathus* and *Leurognathus* larvae of the same size, the eye of *Pseudotriton* has about ½ the diameter. My specimens of *schencki* have 16 costal grooves.

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THE GESTATION AND INCUBATION PERIOD OF AN ARIZONA KING SNAKE.—Two mating snakes, *Lampropeltis getulus yumensis* Blanchard, were collected 26 miles southeast of Tucson, Arizona, on April 17, 1946, by William Woodin III. They were placed in his live collection for observation. The female (WHW 115) laid six eggs on June 17. One of these hatched on August 11. The other five failed to incubate. Gestation 60 days; incubation 54 days.

The male (WHW 164) is rather like *L. g. splendida* B. & G. in pattern, having 36 bands. The female is more typical of *L. g. yumensis* in the possession of 25 bands. The young individual (WHW 145) has 29 bands and has a pattern rather similar to that of *yumensis.* Proper definition of these subspecies is to constitute part of a more general publication by Mr. Woodin.

James Knepton (Herpetologica, 7 [2]: 85, 1951) reported on a copulating pair of king snakes (*L. g. getulus*) from Cedar Key, Levy Co., Florida. Seven eggs were laid after a gestation period of 60 days, and five hatched after an incubation period of 59 to 60 days.—*Frances Humphrey, Box 276, Wickenburg, Arizona.*

A NEW LOCALITY FOR THE GREEN SALAMANDER AND WOOD FROG IN NORTH CAROLINA.—*Aneides aeneus* (Cope and Packard), as reported by Gordon (1952, Amer. Midl. Nat. 47(3):666-701) has been found in North Carolina only at Granite City (Jackson County), Highlands (Macon County), and Bat Cave (Rutherford County.) We took six adults July 9, 1955, in narrow cracks in gneiss cliffs and fallen blocks on the south face of Cold Mountain, in Transylvania County but within a few hundred feet of the Jackson County line, at about 4400 feet elevation. One cluster of eggs was seen then, but not collected. At the same site we found three more adults, including one female attending a cluster of 23 eggs, on July 10, 1956. Two others were seen, one a female with about 30 eggs, which were not taken.

The living salamanders, as compared in the field with a more "normal" type such as *Plethodon shermani melaventris*, are conspicuously flat, with broad heads, soft bodies and large feet. They are more sluggish in response to disturbance, seldom running but either crawling forward slowly or squeezing farther back into a crack. When viewed at a little distance, the dorsal pattern of green spots and blotches provides excellent camouflage against the wet, lichen-covered rock. Eggs in the cluster of 23 showed no evidence of cleavage. The diameter was between 4.8 and 5.1 mm. Gordon (*loc. cit.*) gave the average diameter of eggs at the Highlands site as 4.5 mm. The clear, sticky jelly capsule around each egg (in our set) was from .2 to .5 mm. thick, and extended into a stalk by which the egg was stuck to the rock; from one to ten eggs were attached to a single stalk, but all hung in a compact cluster.

Gordon and Smith (1949, Copeia (3):173-175) noted no "effort of defense" by the females guarding the eggs when they were disturbed. The females which we found with eggs both snapped at the end of the wire being used to dislodge them, but did so only when in immediate proximity to their eggs.

A wood frog, *Rana s. sylvatica* Le Conte, was also taken at Cold Mountain, a female with snout-vent length of 76 mm., on the trail in maple, oak and chestnut forest about 100 yards south of the cliffs. The nearest published localities for this species are in Oconee and Pickens Counties, South Carolina (Quinby, 1954, Herpetologica 10(2):87).

This Cold Mountain site is the same as described for the "cliff-dwelling" salamander *Desmognathus perlapsus* Neill (Eaton, 1954, Herpetologica 10(1):41-43). On July 10, 1956, we found there 14 more *perlapsus*, from 23 to 86 mm. in length; a small female with a cluster of about 19 eggs was seen but not taken.

This investigation is a part of the research of the senior author aided by a Grant-in-Aid from the National Science Foundation administered through the Highlands Biological Station.—*Theodore H. Eaton, Jr.* and *George T. Eaton, East Carolina College, Greenville, North Carolina.*

Frequency of Skin Shedding in the Northern *Banded Water Snake*[1]

By E. E. Brown

INTRODUCTION

Data regarding frequency of molting in snakes have been accumulating for a number of years. Dixon, referring to British Indian species, states that young snakes usually shed more frequently than older ones. Kellogg and Pomeroy noted that sheddings occurred every three to four weeks in a brood of young water snakes *(Natrix s. sipedon)*, less frequently with the parent snake. Klauber found that young Pacific rattlesnakes *(Crotalus viridis oreganus)* shed three or four times during each of their first two years. With regard to 21 snakes of several species kept indoors in an unheated room, Stabler recorded an average interval of 1.5 months between non-winter sheddings. Two water snakes *(Natrix s. sipedon)* among these specimens averaged intervals of 1.9 and 1.4 months, respectively. Givens reports that captive specimens of the green python *(Chondropython viridis)* of New Guinea and New Britain sloughed off skins at intervals of 35 days. Littleford and Keller reported an extensive series of shedding dates for *Elaphe o. obsoleta* and *Natrix s. sipedon* kept at room temperature. The data for their five specimens of Natrix indicate that the interval between summer sheddings in ten cases averaged 33.2 days. For three king snakes *(Lampropeltis g. getulus)* kept indoors, Wilson and Friddle recorded an average interval of approximately 37 days between summer sheddings (if I interpret their data correctly). Allen and Swindell state that the cottonmouth moccasin sheds "about four to six times a year" in Florida. Hudson reported the mouth-gaping that initiated shedding in a specimen of *Cerastes vipera*. Saint Girons noted two to four moltings per year for *Vipera aspis*. Liner observed the first and second sheddings in newly-hatched young of *Coluber constrictor flaviventris*. Additional indoor shedding records have been provided for *Drymarchon corais couperi* by Carson, for *Echis carinatus* by Mehrtens, for *Drymarchon* and *Naja* by Perkins, for *Ancistrodon piscivorus* by Stabler (1951) and for *Boiga dendrophilus* by Barach. Fitch, and Woodbury and his co-workers, Heyrend and Call, present evidence that *adults* of *Crotalus viridis oreganus* and *Crotalus v. lutosus* seldom molt more than once per growing season. Neill described what appeared to be an increased shedding rate in *Drymarchon* and *Natrix* following injuries of the head or neck region. He was followed by Munro (1950) and Loomis who contributed evidence regarded as supporting this idea. Perkins urged that, although injured snakes might eventually be proved to shed more frequently than uninjured ones, greater caution should be exercised to avoid possible premature interpretations. We really are not yet certain what "normal" shedding rates would be for any of these snakes under *natural* conditions.

In reviewing this material several observations appear to be pertinent: (1) Some published notes have been based upon very limited

[1] Extracted in part from a doctoral thesis at Cornell University.

series of sheddings. Because of the variation that may occur within a series, this procedure is open to question. (2) Some observations have been based upon specimens kept indoors, with data lumped from sheddings at all seasons of the year. Apparently no observations have been aimed toward ascertaining whether indoor and outdoor results would agree. (3) There appears to be a reasonable need for series of shedding observations made on representative genera from different geographic regions. If the specimens used are kept out-of-doors *on the ground* and exposed to more natural conditions of temperature, humidity, etc., our conclusions are somewhat more likely to be applicable to shedding as it may occur in nature. (4) According to present information, *Crotalus* in the western United States appears to have a shedding schedule quite different from that of *Natrix* in the east.

The following data enlarge somewhat upon the previous published information concerning skin-shedding in one species, the northern banded water snake, *Natrix s. sipedon* Linnaeus.

During the summer of 1938 at Ithaca, New York, from mid-June on, constant record was kept of the skin condition of a number of northern banded water snakes. These snakes were kept under outdoor conditions. About one-third of the specimens were in an enclosure 4 by 6 feet and about 7 feet high, roofed, but screened and open from ground to roof on all sides. The remaining specimens were in an unroofed wire enclosure having a ground area of approximately 56 square feet. The snakes had ample water supply and cover at all times. Practically all specimens were feeding readily. Incidental to the carrying on of other work with these specimens, it seemed advisable to gather available shedding information from snakes that were living under conditions resembling normal environment. More comprehensive, and satisfactory, results would have been obtained if all snakes had been on hand during the entire period of observation. A few were available for only one shedding.

LENGTH OF INTERVAL BETWEEN SHEDDINGS

In 41 cases involving 23 individual snakes the interval between sheddings varied from 20 to 49 days with a mean of 30.5 days. Sixty-one per cent of the 41 cases fell between 20 and 30 days, 85 per cent fell between 20 and 39 days.

As indicated by the position of the mean, this distribution is not symmetrical. With a mode in the region of 4 weeks, it is skewed toward the long-interval end. This is apparently the result of longer average intervals toward the close of the season of activity. The longer interval presumably is correlated with cooler weather conditions, which would decrease both metabolic rate and food intake. (Mean temperatures dropped from the low seventies during July and August to the high fifties for September and the low fifties for October.) While all long intervals by no means accompanied (preceded) September sheddings, nevertheless, almost no short ones occurred at this time. If the intervals for September sheddings and the one in October be omitted altogether from the calculations, the mean interval is lowered only to 29.0 days. On the other hand, the mean interval for the 11 sheddings that occurred

after September 1 is 35.1 days, that for the 5 sheddings after September 15 is 39.8 days.

Age of the snakes did not seem to make any significant difference in the length of the intervals between sheddings. The interval for 15 sheddings by 8 young individuals (245 mm. to 700 mm. in length) averaged 29.6 days (standard error of the mean=1.811). For 25 sheddings by 14 adults (760 mm. to 1200 mm.) it averaged 30.4 days (standard error of the mean=1.559). Comparison of these means by the method of Simpson and Roe (1939) does not seem to indicate that the above difference is significant (deviation÷standard error of deviation=.343).

Regarding possible variation with sex, the available data apply only to young snakes and are inadequate. The interval for 8 sheddings by 4 young females averaged 29.0 days. That for 7 sheddings by 4 young males averaged 30.2 days. These samples are considered to be too small to make any test of significance here worthwhile.

PRE-MOLT PERIOD

Attention is often called to the cloudy, "milky", or opaque appearance of the epidermal covering of the eyes previous to shedding, and to the general dimming or partial obliteration of the color pattern of the skin at this time. Merely for convenience, the term "pre-molt period" is here applied to the period from the onset of cloudy eye appearance to, but not including, the day of actual shedding.

In a series of 66 cases involving 35 snakes the mean length of the pre-molt period was 6.9 days, with a standard deviation (for the series) of 2.65. The range of variation was 2 to 14 days. Curiously enough, both these extremes were recorded for the same individual snake. Of 12 cases in which the period had a length of 10 or more days, all but one occurred during September.

The eyes do not remain cloudy throughout the pre-molt period. The period may thus actually be divided into 2 sub-stages. During the first, the eyes present a cloudy appearance of varying intensity; during the second, they again present a practically normal appearance, although shedding has not yet occurred. In the 66 cases the "cloudy" stage averaged 4.4 days in length, the subsequent "clear" stage 2.5 days.

The term "pre-molt period", based on the appearance of the eye, is somewhat misleading. The approaching molt may often be forecast by a cloudy or obscured pattern, especially of the belly region, before the eyes give any indication. In 41 cases (involving 23 snakes) this obscuring of belly pattern was noted on an average of 2.1 days before any eye cloudiness was evident. The variation was 1 to 9 days, 78 per cent of the cases being either 1 or 2 days. Of the 9 cases of 3 days or more, all but one occurred during September.

NUMBER OF SHEDDINGS DURING A SEASON

The length of the interval between sheddings, plus other evidence strongly suggests that water snakes in the Ithaca region of New York may be expected to shed about four times during a season. In many cases the same snakes were not on hand throughout the entire period of

observation. Table 1 gives the shedding schedule of 10 specimens kept during 3 or more sheddings. It records the final shedding of the season for each specimen and what is believed to be the first shedding for some specimens.

TABLE 1
Shedding Schedules of 10 Specimens

	Dates of Shedding			
Number	June	July	August	September
1		10	3 & 31	
2		10	4 & 24	
3		12	9	4
4		19	16	29
5	13	3	1 & 25	
6	7	3	5 & 26	
7	14	14	9	3
8	20	10 & 30	23	29
9	14	25	20	
10	20	27	28	

The question immediately arises as to whether numbers 1 to 4 in table 1 may have shed prior to July. Field collections contribute evidence, for during the spring of one or two years it was noted that no freshly shed specimens were seen before about the first of June. About this time a wave of sheddings seemed to begin. A more careful check was kept on this point during 1938 and 1939. Among 60 specimens of 1938, collected between the time of emergence (late April) and mid-June, no individual in shedding condition was seen before the first of June. Nineteen were noted during the first 3 weeks of June. In 1939 the first shedding specimen was seen during the last week of May.[2] There were many during this week and the first week of June. In spite of the apparent wave-like nature of the summer's first series of sheddings, this suggestion of rhythm seemed largely to be lost during the rest of the season.

Of the 10 specimens listed in table 1, it seems probable that numbers 1 to 4 each shed once some time during June. This would make them agree with numbers 5 to 7 which are believed to represent the more normal and usual pattern, with a first shedding during June (or late May) and a fourth (final) one during September, or late August. Number 8, with its 5 sheddings, is probably exceptional. Moreover, this specimen presents the possibility of still another molt preceding that of June 20. This would give it a possible total of 6 for the season. Numbers 9 and 10 are also considered exceptional in showing only 3 actual sheddings each for the season.

[2] Grant (1935), observing water snakes at the Grassy Fork Fish Hatchery in west-central Indiana (latitude of Baltimore) in the spring of 1933, stated that the first individuals with cloudy eyes were seen about the middle of May. The first the writer has seen in Piedmont, North Carolina have been about the first of May. Burger, Smith and Smith (1949) found 6 specimens of *Farancia*, all in pre-shedding condition, in rotten logs around a pond in Hardin County, eastern Texas, on May 1.

Among specimens that the writer has kept from one season to the next (out of doors) there has been no evidence of winter shedding; nor would such an occurrence seem logically possible in the Ithaca region.

TABLE 2. Summary of Data on Sheddings

	Range	Mean	Standard error of mean	Standard dev. of distrib.	No. of cases involved	No. individual snakes involved
Interval betw. sheddings	20-49 da.	30.5 da.	1.24	7.91	41	23
Pre-molt period	2-14 da.	6.9 da.	.33	2.65	66	35
a. Cloudy eyes	1-9 da.	4.4 da	.22	1.75	66	35
b. Clear eyes	1-8 da.	2.5 da	.18	1.47	66	35
Wt. of shed skin (in % of original wt.	.48-.93	.74	.04	.129	12	12

WEIGHT OF A SHED SKIN

The weights of 12 shed skins (dry) at hand range from .05 gm. for a young male of 294 mm. to 3.02 gm. for a 1085 mm. gravid female. That for a 1190 mm. non-gravid female is 2.99 gm. The data on these specimens are included in table 3 to give a rough idea of the relation between size and weight of snake and weight of shed skin. In order to make their skin weights more comparable, they are converted to *percentage of the weight of the snake previous to shedding.* At least for this group, the mean weight of a dry shed skin is .74 per cent of the weight of the snake.

TABLE 3
Shed Skin Data

Sex	Length (mm.)	Weight of Snake (gm.)	Weight of Skin (gm.)	Percentage of Weight of Snake
M	294	5.38	0.05	.93
M	300	9.2	0.08	.91
M	286 (+ tip)	9.66	0.08	.79
F	300	10.	0.09	.89
F	305(+)	12.1	0.09	.73
F	368	22.6	0.16	.72
M	621	70.7	0.54	.77
F	887 (+)	290.8	2.18	.75
F	935	304.3	2.06	.68
F	959	346.	1.66	.48
F (gravid)	1085	478.8	3.02	.63
F	1190	468.0	2.99	.64

TONGUE MOLTING

Kauffeld (1941) has called attention to the fact that the tongue tips of snakes undergo periodic shedding. In the course of the present observations the writer also became aware of this feature. The following remarks are based upon observation of only about a dozen cases.

The two branches, or tips, of the tongue comprised the region involved in the shedding. The sloughing for each tip began medially at the base of the bifurcation and laterally at a slightly more proximal point. The sloughed epidermal layer from each tongue tip was thus slenderly conical with, however, a lateral margin longer than the medial. The sloughs from the two tips usually came off separately but, in one case, they came off together and were joined medially.

The writer's observations differ slightly from those of Kauffeld in that there did seem to be a definite, although not exact, correspondence between the time of tongue sloughing and that of body sloughing, as though both were part of a general process. The timing, however, was quite variable. In one case the tongue sloughed at a time when the eyes were not yet cloudy, although the belly pattern was. In other cases the eyes were very cloudy. In another, skin shedding had just been completed a few minutes earlier. In still others, the skin had been shed a day or two earlier. Further irregularity results from the fact that the sloughs from the two tongue tips do not necessarily come off at about the same time. In one observed case a period of four days elapsed between the sloughings of the two tips.

EFFECT OF MOLTING UPON GENERAL ACTIVITY

The general indisposition of snakes during the molting period has often been remarked upon. Tongue molting may contribute another reason for the decreased activity at this time.

As yet, the writer has no personal record of ever having collected a snake that was in the cloudy-eyed, pre-shedding condition that also contained food. Nor are such individuals usually found actively foraging. The writer has had occasional *captive* individuals that continued voluntarily to take any food offered throughout the shedding period. And he has seen a *captive* individual with intensely cloudy eyes capture and swallow a frog that hopped too near it. However, in a number of other instances, the regular feeding of captive specimens has been interrupted during the shedding period.

The inconclusive nature of these observations on captive specimens might be due to the variability in the exact time of tongue molting as compared to skin shedding. Assuming that tongue sloughing might interfere with the functioning of the Jacobson's organ mechanism, it seems likely that there would be correlated temporary inactivity of the snake.

Mating in our snakes seems to take place at such times as not to be interfered with by shedding. Spring mating seems to precede the season's first shedding. Such autumn mating as may occur is likely to follow the last shedding of the season.

With regard to the decreased activity associated with shedding, there seems to be an open question as to the relative importance of eye condition, tongue condition, general cutaneous sensory condition, general metabolic disturbances (as suggested by Benedict, 1932, and others), or other possible factors.

SUMMARY

Shedding data were gathered from a number of northern banded water snakes that were well-fed and kept under outdoor conditions. In 41 cases the interval between shedding averaged 30.5 days. Variations in respect to skin shedding correlated with age and sex were not detected. The "pre-molt period" averaged 6.9 days in 66 cases. In these cases the pre-molt period may be broken down into a "cloudy-eyed" stage averaging 4.4 days and a "clear-eyed" stage of 2.5 days. Evidence seemed to indicate a norm of 4 sheddings per season, with some variation both ways. The dry weight of a shed skin averaged .74 per cent of the weight of the snake previous to shedding. Tongue tip molting is discussed. It is thought to contribute to the inactivity of snakes at the time of shedding.

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DEPT. BIOLOGY, DAVIDSON COLL., DAVIDSON, N. C.

Secondary Sexual Characters and Ontogeny of Color-pattern in a Cuban Snake (*Alsophis*)

By Chapman Grant

A series of 17 *Alsophis augulifer adspersus* (Gundlach and Peters) was taken while visiting at the United Fruit Sugar Company at Nipe Bay, Oriente, Cuba, April 9-23, 1956. Various sizes were selected to illustrate changes in color-pattern accompanying growth and to note secondary sexual differences. (S.D.S.N.H., Nos. S19172-88 incl.).

Three female and two male hatchlings: 240 to 400 mm. snout-vent are brown with indistinct, interrupted dark bars across body about five scales apart; bars become fainter caudad, appearing on tail as four rows of dark dots; bars formed by dark pigment specks along edges of scales; dark pigment between parietals, outlining rear of frontal; a dark brown line from nostril, outlined by lighter, crosses eye, extends above and along upper labials, crossing upper half of last labial; labials and throat streaked with brown; a dark spot under eye; tail yellowish; undersides light brown; ventrals faintly edged with dark posteriorly.

A male 470 mm. snout-vent; dark crown has spread onto parietals and supraoculars; body scales outlined in dark anteriorly indicating onset of reticulated pattern: posteriorly, groups of dark scales appear in four rows; ventrals dark edged.

Four males and three females 525-610 mm. snout-vent; black crown involves nearly all of parietals, posterior half of frontal and supraoculars; a dark nuchal spot; anteriorly, body brown, reticulated, but still showing traces of juvenile bars which concentrate posteriorly into four rows of black spots, extending onto tail; posteriorly body distinctly gray; ventrals dark; mottled in males, solid slate color in females.

Three females 700-740 mm. snout-vent; fading of stripe over labials, spot under eye and nuchal spot; anterior reticulation nearly complete; bellies darker; black crown solid; body brown anteriorly, gray posteriorly.

A female 1200 mm. snout-vent; black on head concentrated on crown; head and neck gray; anterior reticulation complete, each scale edged with black, centers light tan; posterior part of body and tail gray with four lines of black scales; belly clouded; posteriorly and under tail mottled gray, brown and pastel shades of orange-red and lemon-yellow. The series shows no significant sexual color-pattern differences.

Apical scale pits show no change with growth of snake; no pits on head, neck or under jaw; rarely a few single pits on first and second rows; most dorsals bear two pits, rarely one; where two rows join there is usually one large scale bearing 3 or 4 pits. No secondary sexual significance noted in number or distribution of pits.

A fixed asymmetry was noted in the divided anals of this genus. (Herpetologica, 1937, 2 :114-117). The right section of the anal is smaller than the left and the dividing line passes obliquely caudad left to right, but the free, median edge of right section lies atop larger left hand part. An exception occurs in one male, No. 11, in the present series, wherein these conditions are reversed. In this specimen, the diagonal line lies caudad right to left and the larger left part lies atop the right. This is the only such case noted in hundreds of specimens examined, except in

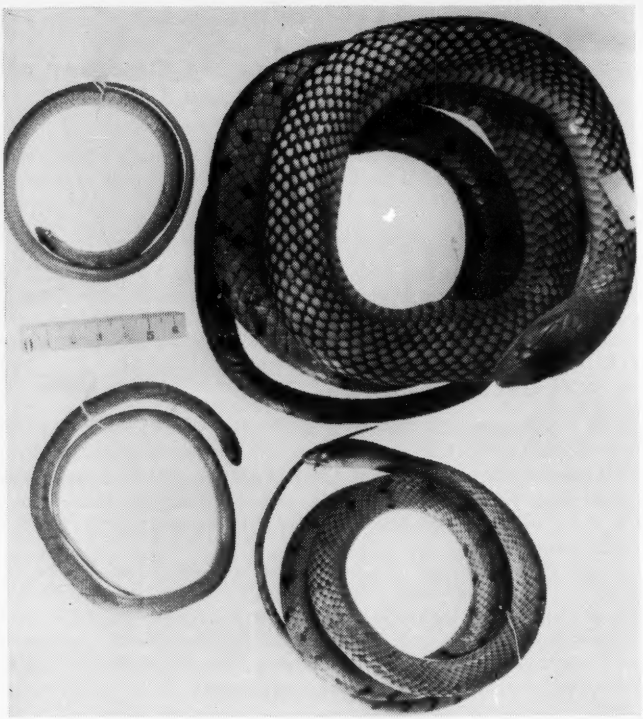

Fig. 1. Two immatures at left show dark bars without differentiated body pattern. Lower right; immature dark bars persist on brown body; reticulation has begun anteriorly; four rows of slate-black spots appear posteriorly. Upper right; adult female; crown black; reticulation complete anteriorly; posteriorly, black scales on gray body and tail.

Alsophis ruttyi Grant, from Little Cayman Island, wherein the females have the anal entire.

Secondary sexual dimorphism shows that females have longer, larger bodies and shorter tails than the males. Differences are small, but fairly constant. Caudals ♂ av. 124, ♀ 119; ventrals, ♂ av. 169.5, ♀ 174; tail % of snout-vent, ♂ 49, ♀ 45; body rows dropped about 10 ventrals cephalad in males than in females; body rows 17-17-13 in all females and most males; exceptions in 3 males: 17-13-13, 17-17-12 and 15-17-12; anal bifid in all.

Head squamation very constant; upper labials 8, with 3, 4 and 5 entering orbit; lower labials 10, last one or two blend into lateral scales so that they might be counted 11 or rarely 9; no secondary sexual significance apparent in deviations in head scales.

ROUTE 1, BOX 80, ESCONDIDO, CALIF.

NOTES ON THE CUBAN IGUANA.—Barbour and Ramsden (1919, Memoirs Mus. Comp. Zool., Harvard Univ., 47[2]: 72-213) list six mainland localities for the Cuban iguana, *Cyclura macleayi macleayi* Gray, and comment on the gradual extirpation of the species. Their records represent all the Cuban provinces with the exception of Santa Clara, now Las Villas.

During September, 1955, Mr. Daniel Lyons, of the Natural History Society of Maryland, and the author observed a number of iguanas on the Cuban mainland near the city of Trinidad, Las Villas Province, and on the small island of Cayo Macho de Tierra located about ten miles southeast of the seaport of Casilda, also in Las Villas Province. These observations add a new provincial record to the list of Barbour and Ramsden.

Five individuals were observed on the mainland in typical limestone associations as described by Sutcliff (1952, Notulae Naturae, Acad. Nat. Sci. Philadelphia, 243 1-7) in his discussion of this species as observed on Cayo de la Piedra. In such areas dense vegetation occurs on a thin soil lying over a limestone base. Prickly pear and trailing cactus are typical plants. Iguanas occupying such areas live in natural cavities of the limestone.

Observations were made on Cayo Macho de Tierra on September 12, 1955. The island is approximately one-quarter-mile long and reaches a width of 200 yards. It consists of a low, sandy hill almost completely surrounded by dense mangrove swamps. Vegetation is sparse in the open, sandy central area and consists chiefly of beach grasses. Besides the iguanas, numerous aquatic birds, land crabs, and *Anolis sagrei* were distributed throughout the area. A small colony of *Ameiva auberi* occupied a sandy beach on the west end of the island.

A total of seven iguanas was observed between 10:00 A.M. and noon, five of which were captured. In all cases they were flushed from thick clumps of beach grass.

There are apparently no accounts of *Cyclura macleayi macleayi* entering water as a means of escape. Two individuals entered burrows whereas the other island-dwelling iguanas sought escape by entering the sea. Each one ran parallel to the shore, sometimes for more than one hundred yards, then, turning swiftly, entered the water, swimming out about twenty yards, and remaining motionless beneath eight to ten inches of water. One individual entered the water from an open beach, but in an area where heavy wave action was inhibited by a thick growth of seaweed. The others entered the mangrove swamps in which the water was clear and quiet.

The island-dwelling iguanas inhabit long, shallow burrows similar to those dug by large land crabs. Burrows were observed in the more elevated regions of Cayo Macho de Tierra as well as on three small unnamed islands southeast of Casilda, and could be distinguished from crab burrows by their larger size and the long groove-like tail marks at their entrances.

Of three burrows opened, two contained iguanas. All ran downward at a moderate angle for about two feet and then continued parallel to the surface for six or eight feet. Two ended blindly, whereas the third was found to have two entrances approximately eight feet apart. The

actual dwelling place of its occupant was a small tunnel extending no more than two feet from one of the entrances.

Local observers insist that iguanas invariably leave the burrows tail first. This is perhaps true in view of the size and structure of the burrows, the diameters of which vary from four to eight inches throughout their length. In no case was an enlarged terminal room observed. Both of the individuals found in burrows were facing down-burrow in very tight quarters and were collected by grasping the tail.—*Jerry D. Hardy, Jr., Dept. Zoology ,Univ. Maryland, College Park, Maryland.*

OCCURRENCE OF THE DWARF TOAD IN ARGENTINA.—In 1952 Myers and Carvalho (1952, Zoologica, 37: 1-3) described a new pigmy toad, *Bufo pygmaeus,* known only from a series of specimens collected in December, 1948, in the scrub beach vegetation at Marambaia, mouth of the Rio Parahyba, in the state of Rio de Janeiro, Brazil. The authors considered the systematic and generic status of the species, regarding it as an allopatric form in the "Rassenkreis" of the *Bufo granulosus* complex and surmising occurrence of intergradation with *B. g. d'orbignyi* somewhere along the Paraguay Basin northward along the west toward Rio de Janeiro.

In November, 1949, I collected two adult toads, a male and female, 10 km. from Ituzaingo, Corrientes, Argentina. They agree closely with the description of *B. pygmaeus.* Dr. G. S. Myers kindly compared a description of the Argentine examples with topotypic *B. pygmaeus* and concluded that they differ from the latter only in "the heavier spotting of the venter and the lesser number of spinose warts on the dorsum." Male, snout-vent 30 mm., female 35 mm.

Bufo granulosus d'orbignyi was not captured at this locality, but is very common in all the mesopotamic areas of Corrientes (Freiburg, 1942, Physis, 19: 219-240). It may accordingly be assumed to be sympatric with *B. pygmaeus* and although similar in many respects, the two species are clearly different.

Accordingly, *B. pygmaeus* is now known to have a range of at least some 1500 km., from the mouth of the Parahyba, Brazil, to Ituzaingo, Argentina. Although it is a member of the *B. granulosus* complex, it is not a subspecies.

The habitat of the Ituzaingo specimens may be of significance. The specimens were taken while calling at midday in a widespread steppe similar to the type locality. The toads are burrowing forms and during the day remain generally very quiet, calling from the opening of their characteristically inclined cylindrical galleries. In the morning of their capture the soil was 43.5°C. I observed many temporary pools in the grassland near the river, with *Carex* as the predominant plant. The water was 34.5°C. in the sun, 24°C. in the shade. In the same habitat I observed *Pseudopaludicola falcipes, Leptodactylus ocellatus, L. chaquensis* and *L. sybilator,* the latter specially active and abundant.

I wish to express my appreciation to Dr. G. S. Myers of Stanford University for his kindness in comparing data and specimens for me.—*J. M. Cei, Departmento Investigaciones Cientificas, U.N.C., Mendoza, Argentina.*

AUTUMN MATING OF THE ROUGH GREEN SNAKE.—Although the rough green snake, *Opheodrys aestivus* (Linnaeus), is common in much of its range, field observations of its behavior are few. On September 17, 1955, near Lanexa, New Kent Co., Virginia, while repairing the roof of a house, I noticed two of these snakes in a pecan tree. When first noticed, they were approximately 20 feet from where we were and 10 feet above ground. Even though the snakes were crawling rapidly in an intricate pattern I could see definitely that they were in copula. The terminal twigs of the pecan had dense foliage and the snakes were rapidly weaving in and out of the leaves, occasionally crossing to other twigs. At intervals they would pause, or crawl slowly, then suddenly go into the fast swirling motion that first attracted my attention. Although their movement was fast, the total distance moved in 15 to 20 minutes was only 3 feet. After a period of being motionless, the male left and climbed higher in the tree. The female remained coiled in the sun on the lower branch. The female was much larger than the male and almost olive drab in color. The male was small, slender and very bright green. The snakes were observed from approximately 3:30 P.M. to 4:00 P.M. The day was warm and sunny and the snakes were in full sun on the west side of the tree.—*Neil D. Richmond, Carnegie Museum, Pittsburgh, Pennsylvania.*

THE NUMBER OF EGGS LAID BY THE CALIFORNIA NEWT. —storer's "A Synopsis of the Amphibia of California" is still the best source for the number of eggs laid by the California Newt, *Taricha torosa* Rathke. The collection of egg masses in a few southern California streams reveals that the number of eggs in a cluster is higher than that recorded in the literature.

Table I. EGG MASS COUNTS IN *Taricha torosa*

County and Location	No. of Masses	No. of Eggs	Min.	Max.	Ave.
1. Alameda, Thornhill Pond (Storer)	24	399	7	29	16.6
2. L.A., San Gabriel River	32	608	8	28	19
3. Orange, Silverado Creek	48	1049	10	39	21.9
4. Orange, Santiago Creek	26	557	7	30	21.4
5. L.A., Las Flores Creek	10	229	11	39	22.9
6. Total S. Calif. (2-5)	116	2443	7	39	21.1
7. Total for species (1-5)	140	2842	7	39	20.3

Table I shows a comparison of egg counts for southern California streams and Storer's records from the literature. In addition one egg mass laid by a *Taricha torosa* in captivity contained 47 eggs. Dates for the five collections listed in the table are, in order, from top to bottom, Jan.-Feb., 1922; April 8, 1952; May 9, 1954; May 16, 1954; and Mar. 24, 1956.

These data suggest that the average number of eggs per cluster for *Taricha torosa* either is higher for the whole species than recorded by Storer, or the number is slightly higher toward the south. More data are required to permit a conclusive interpretation.—*Arden H. Brame, Jr., 340 South Clark Drive, Beverly Hills, California.*

A DEKAY'S SNAKE OF RECORD LENGTH.—The occurrence of the eurytopic DeKay's Snake, *Storeria d. dekayi* Holbrook, in vacant lots of many of the larger cities in northeastern United States is well known to herpetologists. During the past few years such a habitat, located at 3rd Avenue and 12th Street, Newark, New Jersey, has become popular to several amateur herpetologists who have collected numerous specimens there.

On March 24, 1956, three adult specimens were collected from beneath a rock; the day was cold, residual snow covered the ground in places and more snow fell the following day. One of these snakes (AMNH 75816) measured 483 mm. In measuring this specimen after fixation in preservative, it was found to measure 465 mm., 18 mm. less than in life. Other noteworthy specimens collected in the same lot measured 420 and 433 mm.

Mr. Edward Donoghue kept this exceptionally large female under observation in captivity where it fed readily on earthworms. It molted at monthly intervals and on July 10th it was noted that it was gravid. On July 22 twenty-six fully developed dead young were born. It is not known when fertilization took place as it was kept with others of its kind in captivity. Littleford (Copeia 1945, 1:50) reported a brood of 27 from a 133 mm. specimen.

It seems remarkable that specimens should reach such sizes in such settled localities in the face of depredations of cats and Norway rats.—*Charles R. Hackenbrock, Staten Island Zoological Society, New York.*

ANOTHER RECORD OF THE BLACK KING SNAKE IN OHIO.—*Lampropeltis getulus niger* (Yarrow) has been recorded by Conant (Reptiles of Ohio, 1951) in only four counties of Ohio: Adams, Lawrence, Scioto and Jackson. A specimen I captured June 30, 1956, 1¼ mi. S.E. Givens, Pike County, Ohio, adds another county and extends the range about 40 miles northwest. The specimen, measuring 44⅛ in. total length, exceeds the dimensions of the largest recorded by Conant at 40½ in. The snake laid nineteen eggs July 9, 1956; they average 31.4 mm. by 18.5 mm.—*William Hugo Foor, 112 East Main Street, Hillsboro, Ohio.*

AN UNRECORDED FOOD ITEM OF THE TIMBER RATTLESNAKE.—A captive timber rattlesnake, 15 inches in length, ate a *Eumeces fasciatus* (Linnaeus) in May of 1956. The snake had been captured the previous summer in St. Louis Co., Missouri, and had fed readily on small mice. Although recorded food items of *C. horridus* (Linnaeus) are limited to warm-blooded animals, it would not be surprising to find that juveniles are less discriminating in their choice of prey, as indeed is the case with both adults and juveniles of the more primitive moccasins (*Ancistrodon*).—*Charles W. Myers, 1002 N. Kingshighway, St. Louis 13, Mo.*

A BLIND SNAKE PREYED UPON BY A SCORPION.—There are few published accounts of natural predation on the small nocturnal species of desert snakes. It is assumed that ophiophagous snakes, birds (owls), certain mammals such as badger and coyotes are the most important enemies of such species as *Chionactis occipitalis* (Hallowell), *Phyllorhynchus decurtatus* (Cope) and *Leptotyphlops humilis* (Baird and Girard) *Leptotyphlops*, due to its small size, must be suitable prey for a greater number of animals smaller in size than those listed above. This is borne out by a recent field observation made by M. S. Wasbauer, a graduate student in Entomology at the University of California. While collecting at Cronise Station, east of Barstow, San Bernardino County, California, a large scorpion (*Centruroides* sp.) was seen carrying a *Leptotyphlops humilis* in its pedipalps. The scorpion had imbedded its sting into the snake's dorsum at midbody. The snake, 119 mm. in total length, was alive when collected but died soon thereafter. A slight abrasion and some local discoloration were still visible several days later at the site of the sting puncture. Otherwise the snake appeared uninjured.

These observations were made on April 27, 1956, between 9 and 10 p.m. (PST). The scorpion was first seen moving across a sand dune and had presumably caught the *Leptotyphlops* nearby.

This record is particularly interesting when one considers the fact that scorpions are usually thought of as food items for desert reptiles. It is conceivable that the larger scorpions may feed on the young of other desert snakes and may indeed be one of the more important enemies of *Leptotyphlops* throughout the life of that animal, particularly during its periods of nocturnal surface activity. Another important consideration is the effect of scorpion venom on snakes since it would seem that in this instance the *Leptotyphlops* died as a result of the scorpion sting.—*James D. Anderson, Museum of Vertebrate Zoology, University of California, Berkeley, California.*

EXTENSION OF KNOWN RANGE OF THE FLAT-HEADED SNAKE.—A half-grown specimen of *Tantilla gracilis hallowelli* Cope, found crossing the road on the night of June 4, 1956, in Palo Duro Canyon State Park, Randall County, Texas, extends the known range of the species a little more than a hundred miles to the west and is apparently the first record for the Texas panhandle. The specimen (INHS 8300) is a male, 163 mm. in total length, with 125 ventrals, 49 caudals, six upper and six lower labials per side, and a single postocular per side. The head is darkened, but the dark pigment, which gradually fades posteriorly, extends no farther than two scale-lengths behind the parietals. The venter is salmon pink. Palo Duro Canyon is on the Great Plains and within the range of *Tantilla nigriceps* Kennicott. The present record thus provides evidence of an additional area of sympatry of these two closely similar species.—*Philip W. Smith, Illinois Natural History Survey, Urbana.*

A TEN-YEAR-OLD SKINK?—On April 11, 1956, I caught an adult male five-lined skink, *Eumeces fasciatus,* which had been captured, marked (as "1LH 3-4RH") and released on April 7, 1950, at the "Rat Ledge" study area on the University of Kansas Natural History Reservation. This lizard had not been recaptured in the six years intervening, although the area had been searched intensively several times each year. At its second capture the skink was approximately 30 feet from the original location. It was then 82 mm. in snout-vent length—within 1 mm. of the maximum recorded in hundreds of individuals from the same locality. At its original capture in 1950, this skink was 80 mm. in snout-vent length and weighed 11.5 grams, thus it was already an exceptionally large adult.

Because individuals differ greatly in growth rate, age cannot be determined in medium-sized to large adults. One male marked while still a little short of small adult size (65 mm.) at an age of one year, had grown to 80 mm. two years later, but ordinarily four years or more would be required to attain a length of 80 mm. In any case the large male recaptured in 1956 must have been in his ninth year at least, and may have been several years older.

Since more than 50 per cent of the adults in a stable population are eliminated through normal turnover from year to year, probably less than one per cent of those that reach adult size survive to be ten years old. The old recaptured skink seemed fully active and vigorous, but it died two days later, of unknown causes.—*Henry S. Fitch, University of Kansas Natural History Reservation, Lawrence, Kansas.*

AN UNUSUALLY LARGE BLANDING'S TURTLE FROM IOWA. —Previous records of the maximum size limit of Blanding's turtle (*Emys blandingi* Holbrook) show it to be in the neighborhood of 9 inches. Cahn (1937, Ill. Biol. Mon. 16: 75) recorded a specimen from Illinois with a carapace length of 9.45 inches and his appears to be the largest reported to date. A male specimen in the writer's collection has a straight-line carapace-length of 10.25 inches (259.5 mm.). The turtle was found in a shallow prairie lake in Johnson County on May 31, 1955. Other measurements are: width of carapace, 177 mm.; length of plastron, 228.5 mm.; width of plastron, 121.5 mm.; height of shell, 107.5 mm.

In general, most Blanding's turtles observed in Iowa are much smaller than the above and are usually only as long as the width of the above mentioned specimen.—*Christopher H. Dodge, 410 S. Summit St., Iowa City, Iowa.*

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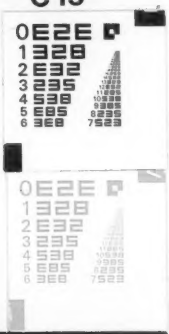
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